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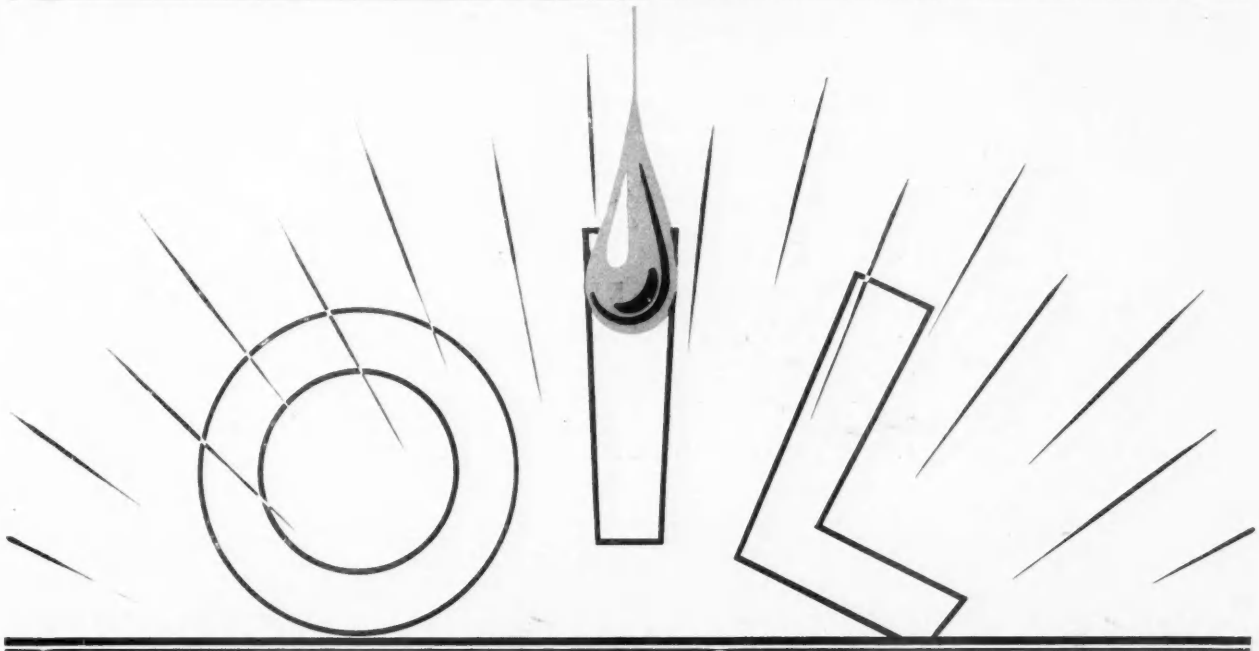

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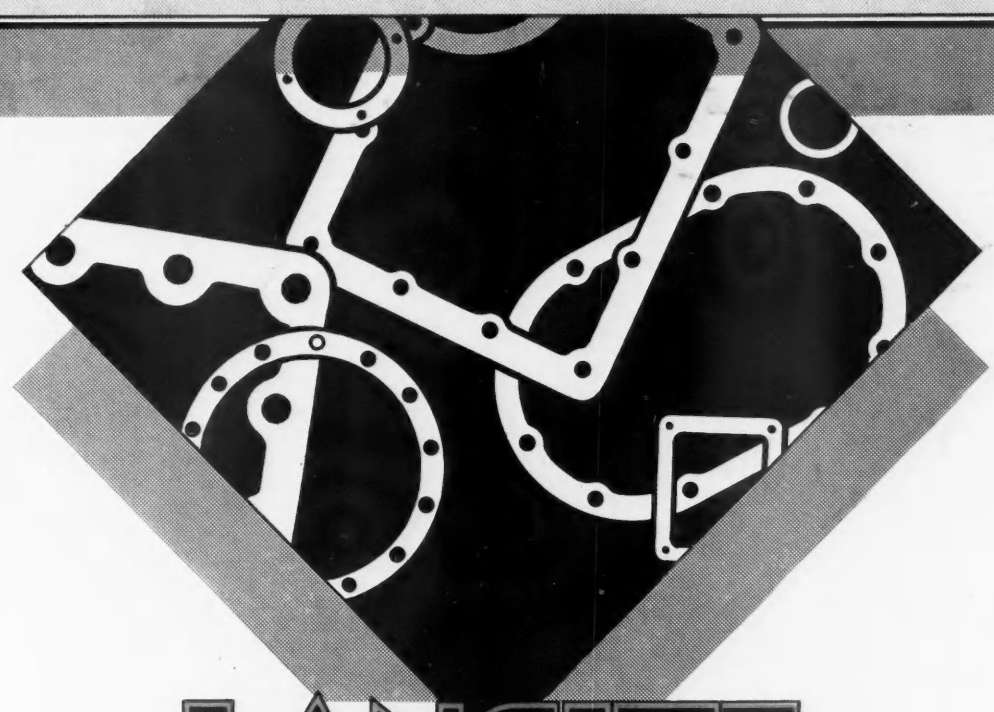

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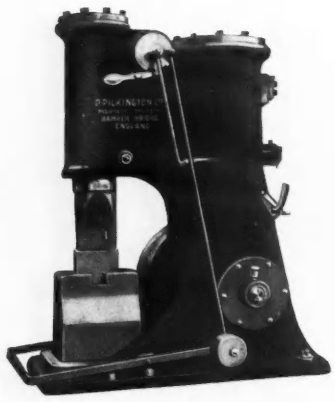

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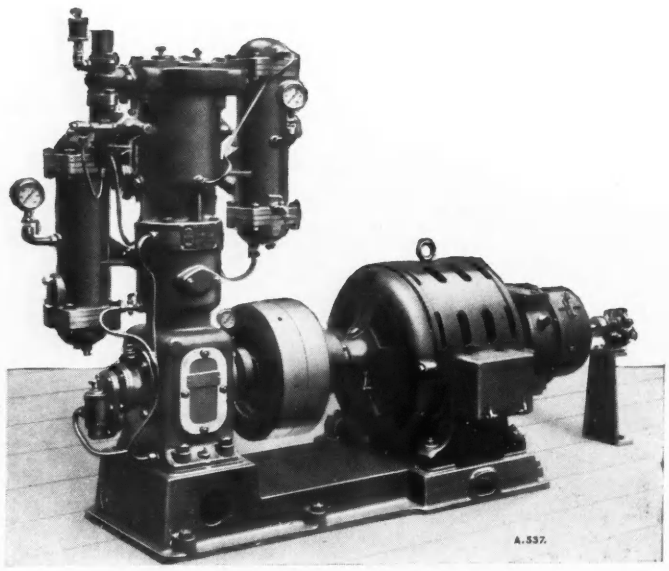

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A Seven-Day Journal

The 1935 Albert Medal.

ON Monday, July 8th, the Council of the Royal Society of Arts attended at Clarence House, when the Duke of Connaught, the President of the Society, presented the Society's Albert Medal for 1935 to Sir Robert Hadfield, F.R.S. In making the presentation, the Duke of Connaught referred to Sir Robert's many researches in metallurgy, his discovery of manganese steel in 1882, and his study of alloy steels, and their behaviour at very low temperatures, which work had, he said, extended the knowledge of metals in a new and important direction. Speaking on Sir Robert's many services to the steel industry, the Duke added that he had consistently upheld the view that the future of industry in this country was closely bound up with the attention it gave to research and throughout a long career he had given much time and energy to forwarding the work and interests of technical and scientific societies and assisting many young workers in investigations of importance to science and to industry. In the course of his reply, Sir Robert Hadfield, thanking the Duke of Connaught, said that he appreciated to the full the presentation from the Society, of which his late father and himself had been members for fifty-eight years. It was his intention to continue in every possible way his support to research and its practical applications. In conclusion, Sir Robert referred with satisfaction to the important increase in the world's steel output for 1935, which at the present rate, he said, would not be far short of 100,000,000 tons. That was nearly double the amount produced in 1932, and compared not unfavourably with the 120,000,000 tons for the bumper prosperous year, 1929.

The Unemployment Figures.

ACCORDING to a statement issued by the Ministry of Labour on Monday, July 8th, there were on Monday, June 24th, approximately 10,361,000 insured persons in employment in Great Britain. That number is 27,000 more than a month ago, 188,000 more than a year before, and 1,035,000 more than in September, 1931, shortly after the National Government was formed. Among the leading industries in which an improvement in employment has been recorded we note the engineering, iron and steel, shipping, shipbuilding and repair, public works, road transport, dock, and harbour and building industries. There has also been a large increase in employment in distributive trades. On the other hand an increase of 37,200 in unemployed miners, largely following the usual summer slackness in coal production, is recorded. This slackness was apparent in practically all coal-producing centres. The number of unemployed on the registers of unemployment exchanges on June 24th totalled 2,000,110, or 44,642 fewer than a month before and 824,662 fewer than in September, 1931. The number of unemployed is especially noteworthy as being the lowest recorded since July, 1930.

Extensions at Selected Generating Stations.

IT is announced that the Central Electricity Board has received the approval of the Electricity Commissioners for proposals for further extensions of the grid selected stations to meet the continued expansion in the demand for electricity. It will be remembered that last year sanction was given for the installation at selected stations of new plant of 535,000 kW aggregate capacity, representing an outlay of £7,500,000, and, as announced by Sir Archibald Page at the National Electrical Convention last month, the full programme of extensions to be initiated during 1935 will aggregate some 650,000 kW of generating plant, which, together with additional boilers and other necessary equipment, will result in further orders of an estimated value of £7,250,000. As part of this year's programme, the Board has already issued directions to the owners of selected stations for the installation of additional generating sets and boilers, which, allowing for certain replacements, will increase the capacity of grid stations by nearly 500,000 kilowatts. Most of this new plant will be in operation by the winter of 1937.

The German Naval Programme.

IN a leading article of June 28th we discussed various aspects of the Anglo-German Naval Agreement and its possible effects on our own naval policy. An announcement published in Berlin gives particulars of the new German vessels which are already on the stocks, or which will be laid down during the year. They include two battleships, each of 26,000 tons, armed with 11in. guns, and two 10,000-ton cruisers, with 7·8in. guns, and sixteen destroyers, each of 1625 tons, with 5in. guns, laid down in 1934 and 1935. The submarine programme comprises twenty submarines, each of 250 tons, the first of which was put into service on June 29th, and two others already afloat; six submarines, each of 500 tons, and two submarines of 750 tons each. Plans for the construction of the first aircraft carrier are in hand, and plans of the further naval vessels to be laid down in 1936, and in the following years, in accordance with the principle of qualitative equality, are now in preparation. It may be pointed out that the vessels in the first four categories given above were either laid down or designed before the signing of the Anglo-German Naval Agreement on June 18th. In the construction of the two large battleships a reply to the recent French battleships "Dunkerque" and "Strasbourg" may be seen, while the powerful flotilla leaders may be taken as Germany's response to the recent "pocket cruisers" of the French Navy. The programme outlined above has been sent to the Governments of all the Naval Powers which signed the Washington Treaty.

A Large Glasgow Dock Scheme.

AT a meeting of the Clyde Navigation Trust, held on Tuesday, July 2nd, a scheme of dock improvement, which will probably cost £7,000,000, was formally approved. The scheme proposed will provide about 4½ miles of wharfage on the south bank of the river, along a river frontage of about 1½ miles. It provides for the layout of docks consisting of two basins to the westward of King George V Dock, with graving docks at the south end of the westmost basin, with a riverside quay running eastward from Renfrew workshops to the westmost basin, permitting of a widening of 200ft. in the river opposite. The Clyde is to be widened at one point by about 200ft., and the new docks will be constructed to the west of the large George V Dock. The Trust has no less than 279 acres of land at Shieldhall and Renfrew available, and is now looking into the question of securing suitable occupiers who desire industrial sites. In the discussion of the scheme, the City Treasurer, Mr. P. J. Dollan, welcomed the new project, which, he stated, was the biggest scheme of its kind put forward in Glasgow during the past ten years. Mr. Dollan said that he was tired of hearing about the decline of Clyde industry, and said that it was the continual preaching of unjustified pessimism which gave the impression that Clydeside was down and out. His view was that the Clyde was relatively in a better economical position than any other port in the world. The annual financial report submitted by Mr. W. F. Robertson showed that the figures for the preceding year were exceeded by £75,000, and the approximate increase in the inward cargoes was 126,000 tons and in the outward cargoes 218,000 tons.

The Mauretania's Last Voyage.

IN a Journal note of last week we chronicled the last sailing of the Cunard White Star liner "Mauretania" from Southampton on Monday, July 1st, to the Rosyth yard of Metal Industries, Ltd., where she is to be broken up. On Thursday morning, July 4th, her telegraph rang "Finished with engines," which is probably the last entry in the log of a very famous steamship. The voyage from Southampton to the Tyne was made at a speed of about 15½ knots, and Captain A. T. Brown called a halt at the Tyne to receive a deputation from the river of the "Mauretania's" birth. The deputation included the Lord Mayor of Newcastle (Mr. R. S. Dalgliesh) and the Mayor of South Shields (Mr. J. W. Watson). From the Tyne to Rosyth, with only twelve of her twenty-five boilers working, a speed of 18 knots was touched. The liner arrived off Leith on Wednesday, and early on Thursday morning she passed under the Forth Bridge. Tugs took her in charge and she entered the dockyard, finally to be docked alongside the late German battleship "Bayern," where she will be deplated and broken up. The chairman of Metal Industries, Ltd., Mr. J. D. Pollock, reminded those present at the last dinner on the ship that the "Mauretania" will continue to live in machinery and steel plates, but there are those who hold that, although the ship is assured of a name in technical history, it would give pleasure to many Atlantic travellers should in the future the same name be given to a leading ship of the company.

The Loss of the Blairgowrie.

ON Tuesday afternoon, July 9th, Lord Merrivale, the Wreck Commissioner, announced at the Institution of Civil Engineers the findings of the Court of Inquiry into the loss of the Glasgow cargo ship "Blairgowrie," which sank with all her crew of twenty-six in the North Atlantic on February 26th. The report deals in detail with the questions put by the Board of Trade, and finds that it is unable to say affirmatively that the "Blairgowrie" was in a good and seaworthy condition as regards the hull and equipment when she left Swansea on her last voyage. It further finds that the vessel foundered in weather of hurricane force, and in regard to its loss no wrongful act or default was shown by the owners or managers. On the whole question of securing the safety of sea-going ships and their crews, the Court is of the opinion that existing provisions fall short of what is necessary. Load-line surveys, it suggests, should have due regard to the general condition of the ship; the instructions to surveyors which were in existence should be made practically effective; and steering gear and hatches should be practically and carefully examined. Default of a survey in respect of matters such as these should entail direct, and, if possible, prohibitive consequences. Evasion by shipowners of the manning regulations—amended, perhaps, with due regard to the objects in view—should be provided against by due penalties. Wilful false statements in logs, ship's reports, ship's papers, and surveys should be so dealt with that the reliability of such documents would not readily be tampered with.

The Royal Air Force Review.

ON Saturday, July 6th, His Majesty the King reviewed thirty-eight squadrons of the Royal Air Force at the Mildenhall Aerodrome, and at Duxford he saw twenty squadrons—182 machines—fly past. The weather was excellent, and all the events were successful. Over 350 aircraft were drawn up for Royal inspection at Mildenhall, and the King with his two eldest sons was attended by the Secretary of State for Air, Sir Philip Cunliffe Lister, and by Air Chief Marshal Sir Robert Brooke Popham, Air Officer Commanding-in-Chief, Air Defence of Great Britain. At Duxford the fly-past occupied close upon half an hour, and consisted in flights and squadron drill, which exhibited perfect order at the take-off, in assembly, grouping, and timing, and at the fly-past. After the review the King sent a message to the Secretary of State for Air in which he warmly congratulated the Royal Air Force on the magnificent display it had given. His Majesty said that he was greatly impressed both by the smartness on the ground and the efficiency in the air, which left no doubt that the Royal Air Force would prove fully equal to any task which it might be called upon to fulfil.

The Dartford Tunnel Scheme.

AT its meeting on Tuesday, July 9th, the London County Council refused to contribute towards the cost of constructing a tunnel between Dartford and Purfleet, on the ground that the traffic would be Kent and Essex traffic which ought never to come to London, and that the cost should be borne by the Road Fund and the local authorities. In a Journal note of January 25th, we outlined the proposals made for the tunnel and the attitude of the local authorities and the Ministry of Transport to the proposal. In a letter of May 20th, the Minister of Transport asked the London County Council whether a contribution from the Council would be forthcoming if the plan was proceeded with. In 1930 the total cost of the work was put at £3,000,000, of which the Road Fund was to bear £2,250,000, leaving £750,000 to be provided by the local authorities. Kent and Essex then consented to contribute £250,000 provided that other contributions from local authorities were forthcoming. In 1931 the London County Council agreed to contribute £150,000, but when the recent letter of the Minister of Transport came before the Highways Committee, that Committee recommended that in view of the recent heavy commitments of the Council no contribution should be made. This recommendation the Council has upheld.

The King's Langley Collision Inquiry.

THE report on the Ministry of Transport inquiry into the three-fold collision on the night of March 13th at King's Langley, involving four L.M.S. goods trains and causing the death of one of the drivers and injury to two others, has just been issued by Lieut.-Colonel A. H. L. Mount. It states that although some of the evidence was conflicting, the circumstances of the accident were simple, and that there was nothing in the case to relieve Signalman W. Gibbs of responsibility for the accident. In his concluding remarks and recommendations, Lieut.-Colonel Mount says that the case illustrates very well how reliance for safeguarding an unusual occurrence is necessarily dependent upon the signalman performing each of his actions with intelligent interest and deliberation, not thoughtlessly but with due sense of responsibility. His work is governed by simple rules, which do not vary, but from which departure may seriously compromise the integrity of block working. Lieut.-Colonel Mount remarks that "no equipment, short of continuous track circuiting, which would hardly be justified, will ensure safety in the hands of an operator who has so little regard for, and interest in, the significance of his block working as to be content to rely upon the telephonic advice of the men on either side of him to verify whether he has carried out his own fundamental duty." Referring to a suggestion that searchlights on the engines might have prevented these collisions, Colonel Mount expressed doubt whether, owing to the curvature of the line at the site, such means would have had even preventive effect. In any case, he holds that the use of searchlights in main line operation in this country would not be desirable from a safety point of view.

Trial Load Analyses of Curved Concrete Dams.

By IVAN E. HOUK.*

No. II.

(*Concluded from page 4, July 5th.*)

TRIAL LOAD ANALYSES IN ARCH DAM DESIGN.

SEVERAL trial load analyses usually will be required in designing an arch dam by the trial load method, particularly if the dam site possesses a shape definitely different from any section previously investigated, or if the profile at the dam site contains abrupt irregularities which cannot economically be removed in the base excavation and which therefore will tend to cause stress concentrations in the finished structure.

Ordinarily, the procedure will be to adopt a tentative cross section and make a preliminary plan of the uplift, tangential shear, and twist action, and making an adjustment of arch and cantilever deflections in the radial direction only. Usually a total of five or six cantilever elements and a like number of arch elements spaced fairly uniformly throughout the dam, will be sufficient in the preliminary trial load studies. If at all possible, it will be desirable to smooth out irregularities in the canyon profile in assuming excavation lines and to adopt a design symmetrical about the crown section for the purpose of the preliminary investigations. Deep holes or relatively narrow gorges in the bottom of the canyon can sometimes be considered as plugged with concrete, and treated as parts of the foundation instead of as parts of the dam.

When the first trial load analysis is completed the tentative dimensions of the structure can be modified, as indicated by the preliminary stress calculations, and the modified design re-analysed. This procedure can be continued, using the simplified, radial adjustment method, until the dimensions of the structure are such as to give satisfactory maximum stresses in both arch and cantilever elements. The final design can then be carefully analysed by the amplified trial load method, including effects of uplift, tangential shear and twist action, cracking in the tension areas when the calculated tension stresses are more than about 50 lb. per square inch, and, if necessary, the effects of unsymmetrical conditions at the dam site. In the final trial load studies it usually will be desirable to analyse about eight or ten cantilever elements and about the same number of arch elements. If the structure is one of unusual magnitude and importance, further trial load analyses of Poisson's ratio effects and non-linear distribution of stress conditions may be needed.

In the final analysis it will be desirable to calculate the direction and magnitude of the principal stresses at the abutments by combining the effects of loads carried by both arch and cantilever elements. These stresses will usually be somewhat higher than the horizontal arch stresses at the same elevations, but somewhat lower than the cantilever stresses in the bottom of the canyon. However, in the case of canyons with vertical walls, the principal stresses at the abutments will equal the arch stresses and may be

TABLE II.—*Curved Concrete Dams Designed by Trial Load Method.—Listed in Order of Decreasing Height.*

Name of dam.	Location, nearest town and state.	Stream.	* Year completed.	† Purpose.	‡ Type of design.	§ Maximum height, feet.	Designed by	Project and miscellaneous remarks.
Boulder	Las Vegas, Nevada	Colorado River	1935	I., W.S., P., F.C., S.C.	C.R.	731	Bureau of Reclamation	Boulder Canyon project
O'Shaughnessy	Oakdale, California	Tuolumne River	U.C.	I. and W.S.	C.R.	430	City of San Francisco	Dam being raised 86ft. (See Page 40).
Owyhee	Owyhee, Oregon	Owyhee River	1932	I.	C.R.	421	Bureau of Reclamation	Owyhee project
Camp Verde	Phœnix, Arizona	Verde River	T.D.	I.	C.A.	340	Bureau of Reclamation	Verde project
Parker	Parker, Arizona	Colorado River	U.C.	W.S. Div.	C.R.	335	Bureau of Reclamation	For Metropolitan Water District of Southern California
Ariel	Ariel, Washington	North Fork of Lewis River	1931	P.	C.A.	313	Electric Bond and Share Company	For the Inland Power and Light Company (See Page 40).
Horse Mesa	Phœnix, Arizona	Salt River	1927	P.	C.A.	305	Salt River Valley Water Users' Association	Salt River project
Seminoe	Rawlins, Wyoming	North Platte River	T.D.	I.	C.A.	261	Bureau of Reclamation	Casper-Alcova project
Calles	Aguascalientes, Mexico	Santiago River	1928	I.	C.A.	219	J. G. White Eng. Corporation	Comision Nacional de Irrigacion, Mexico (See Page 40).
Stewart Mountain	Phœnix, Arizona	Salt River	1930	P.	C.A.	212	Salt River Valley Water Users' Association	Salt River project
Gibson	Augusta, Montana	North Fork of Sun River	1929	I.	C.R.	199	Bureau of Reclamation	Sun River project (See Page 40).
Taylor Park	Gunnison, Colorado	Taylor River	T.D.	I.	C.R.	197	Bureau of Reclamation	Uncompahgre project
Deadwood	Boise, Idaho	Deadwood River	1930	I.	C.R.	168	Bureau of Reclamation	Boise project
Eleven Mile Canyon	Florissant, Colorado	South Fork of South Platte River	1932	W.S.	C.R.	150	Board of Water Commissioners	City and County of Denver
Cat Creek	Hawthorne, Nevada	Cat Creek	1932	W.S.	C.A.	118	Bureau of Reclamation	For Bureau of Yards and Docks, U.S. Navy Dept.

NOTES.—* U.C., under construction; T.D., tentative design, contemplated project. † I., irrigation; W.S., water supply; P., power development; F.C., flood control; S.C., silt control; Div., diversion. ‡ C.R., constant radius; C.A., constant angle. § Above lowest foundation level.

TABLE III.—*Dimensions, Load Conditions and Maximum Stresses for Dams included in Table II.—Listed in Order of Decreasing Height.*

Name of dam.*	Rad. to upstr. face at top, feet.	Width at maximum section, feet.		Length of dam, feet.		Ice load, lb. per lin. ft.	Max. earthquake shock.‡	Uplift assumption.	Conc. temp. at time of closure.	Max. direct stresses, lb. per sq. in.§							Maximum shear stresses, lb. sq. in.	
										Cantilever (incl.).			Arch-full load (horiz.).					
										Empty.	Full.		Crown.		Abutment.			
		Top.	Base.	Arch.	Total.						Upstr.‖	Dwnst.	Ext.	Int.	Ext.	Int.	Cant.	Arch.
Boulder	500	45	659	1220	1220	None	None	0·67 uplift	5° F. below mean annual	516*u*	565*b*	318*b*	223 223*e*	— 25 C	— 12 C 20*p*	231 231*e* 214*p*	154	106
O'Shaughnessy	700	25	290	776	908	None	0·1*g* for 1 sec.	0·5 uplift when cracked	mean annual	413*u*	187*b*	417*b*	157 260*e*	—103 C	—224 C —302*p*	218 439*e* 339*p*	204	153
Owyhee	500	30	255	528	820	None	None	0·5 uplift at drains	Mean annual	356*u*	358	184*b*	169 295*e*	—126 C	—303 C	360 663*e*		
Camp Verde	480	25	138	1139	1710	None	None	0·5 uplift when cracked	Mean annual	357*d*	C	636	235 291*e*	— 65 C	—187 C	127 314*e*		
Parker	315	39	105	802	802	None	0·1*g* for 1 sec.	0·67 uplift when cracked	7° F. below mean annual	387*u*	263*b*	289	542 542*e*	— 1 C	39 C	443 451*p*	65	76
Ariel	397	19·5	93	728	1218	None	None	0·5 uplift when cracked	Mean annual		C	808	441	21	—107 C	560 667*e*		
Horse Mesa	251	8	43	520	784	None	None	Full uplift when cracked	Mean annual		C	659	541	117	— 76 C	679 743*e*		
Seminoe	350	15	89	428	542	25 tons /lin. ft.	0·1*g* for 1 sec.	None, no cracking	10° F. below mean annual	187*d*	7*a*	427*b*	348 348*e*	— 47 C	— 21 C — 66*p*	471 492*e* 471*p*	114	67
Calles	245	8·3	37	333	930	None	None				C	950*b*	720	C	C			
Stewart Mountain	273	8	33	600	1260	None	None		Mean annual		C		602	66	— 57 C	664 680*e*		
Gibson	405	15	87	960	960	None	None	0·5 uplift when cracked	Mean annual		C	605	364 426*e*	— 52 C	— 66 C	334 400*e*		
Taylor Park	365	15	73	865	865	25 tons /lin. ft.	0·1*g* for 1 sec.	0·5 uplift when cracked	5° F. below mean annual	231*u*	C	464*b*	308	18	— 30 0 — 34*p*	154 160*e* 319*p*	183	60
Deadwood	290	9	62	501	749	28·8 tons /lin. ft.	None	0·5 uplift when cracked	Mean annual		C	472*b*	272 369*e*	—140 C	—184 C	305 489*e*		
Eleven Mile Canyon	230†	12†	53	445	445	25 tons /lin. ft.	None	0·5 uplift when cracked	Mean annual	170*u*	C	528*b*	232 260*e*	—101 C	—108 C	348 410*e*		
Cat Creek	110	6	23	237	237	10 tons /lin. ft.	None	0·5 uplift when cracked	5° F. below mean annual		C	413*b*	277 277*e*	— 76 C	—114 C	229 291*e*		

NOTES.

* Analysis included effects of tangential shear and twist in all cases except Horse Mesa, Calles, Stewart Mountain and Gibson; 230ft. of backwater at downstream face of Parker Dam.
† Design later changed to 270ft. radius and 15ft. top width.
‡ Acceleration and period of vibration.
§ Stresses at intrados at crown and at extrados at abutment are minimum compressions in cases where tension does not occur. Minus sign means tension. ‖ Maximum cantilever stresses, reservoir full, given only for Boulder, Owyhee, O'Shaughnessy, and Parker Dams. Earthquake effects not included in empty stresses.
u, upstream; *d*, downstream; *c*, cracked; *p*, principal stress; *a*, minimum upstream compression at lower elevations; *b*, maximum stress occurs at base of crown cantilever; *e*, estimated maximum compression, cracked in tension areas.

dam, introducing as much horizontal curvature as possible, and then calculate the maximum stresses in the structure by a simplified trial load method, assuming tension stresses to transmit internal forces without cracking the concrete, neglecting effects of

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greater or smaller than the maximum cantilever stresses, depending on the width of the canyon and the dimensions of the dam. In the case of massive curved dams like Owyhee and Boulder, listed in Tables II and III, where the maximum cantilever compressive stresses occur along the upstream edge of the base, calculation of principal stresses will show

an appreciable reduction or even the entire elimination of the horizontal tension stresses indicated at abutment locations along the upstream face of the dam by the analysis of the horizontal arch elements.

During the early use of the trial load method cracked arches were carefully analysed, after the arch and cantilever deflections had been brought into radial agreement, whenever appreciable tension stresses were indicated by the preliminary trial load studies. In these analyses the water load was applied at the upstream face of the dam in the regions of cracked concrete as well as in the other parts of the

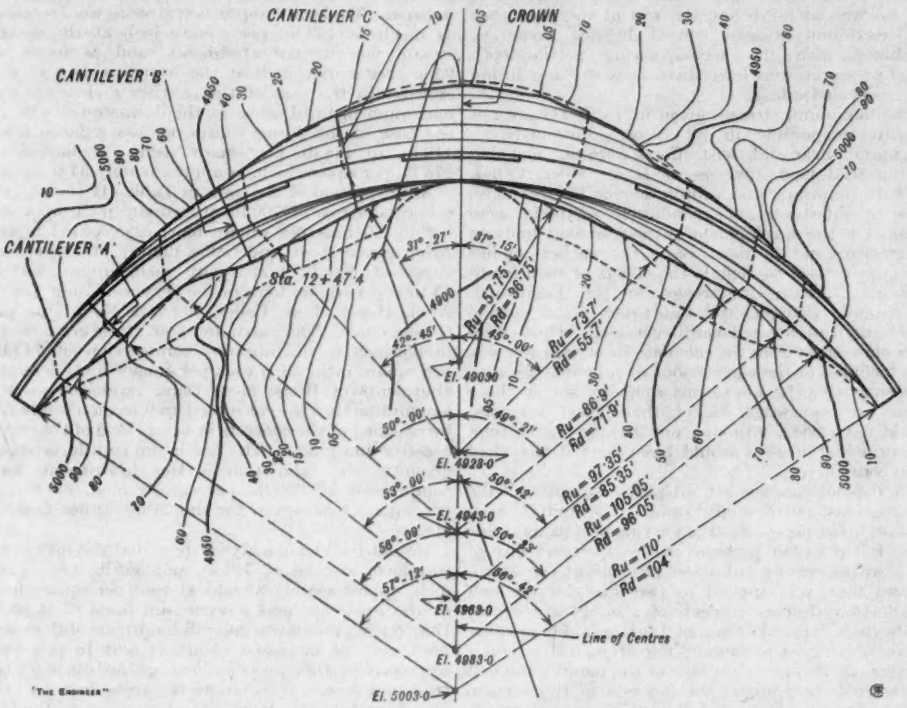


FIG. 3—CONSTANT ANGLE DESIGN—CAT CREEK DAM, NEVADA

structure. However, the reduced thicknesses of the arch rings, leaving out the widths of cracked concrete, were used in calculating moments of inertia and arch stresses, inasmuch as the cracking obviously increases the flexibility of the arches and decreases the net area of cross section available for transmitting stress.

The analysis of cracked arches was gradually discontinued as it became evident that cracking in the arches has no important effect on the distribution of water load between the arch and cantilever elements, and that the maximum compressive stress in the interior or secondary arch occurs at the intrados at the abutment and at the extrados at the crown, and is nearly always very close to the arithmetical sum of the originally calculated compressive and tensile stresses at the edges of the uncracked arch. The fact that cracking in the arch elements has no important effect on the distribution of water load or on the radial deflections, as before mentioned, means that the opening and closing of the radial contraction joints along the upstream face of the dam, during the filling and emptying of the reservoir, has no important effect on the results of the trial load analysis as long as the tension stresses are properly considered.

In more recent trial load designs tension stresses and resultant cracking in the arch elements have been largely eliminated through the adoption of plans for sub-cooling the concrete and grouting the radial construction joints, while the concrete temperatures are below the ultimate mean annual values. Cracking in the cantilever elements is still analysed whenever the preliminary trial load studies indicate tension stresses greater than about 50 lb. per square inch. Uplift forces are included in the analysis of cracked cantilevers, since they tend to increase the radial cantilever deflections, thus affecting the final distribution of water load.

In making trial load analyses for the purpose of determining the design of an arch dam it is usually sufficient to consider the maximum water load; that is, the water load that may be imposed on the structure at long intervals of time due to the occurrence of extreme flood conditions. For such a load the water surface in the reservoir is usually taken at the top of the dam, or at the top of the parapet, if the design provides a solid parapet wall along the upstream edge of the top. After the design dimensions are determined trial load analyses can be made for water loads occurring during normal full reservoir operation and for ice loads combined with partial-depth water loads. Stresses and deflections of cantilever elements can also be calculated for the empty condition of the reservoir. If the dam is situated in a region subjected to earthquake shocks, the effects of the maximum possible earthquake can be combined with all the above-mentioned loads, including the one for which the dam was designed. However, since the assumption that the maximum possible earthquake shock will occur simultaneously with the maximum possible flood is hardly logical, somewhat higher maximum stresses can be permitted under such a severe condition of loading. In the case of storage reservoirs the maximum ice load usually will be applied at an elevation some distance below the top of the dam; so that the maximum stresses due to ice loads, combined with partial depth water loads, usually will be less than the stresses occurring during extreme flood conditions. Tail water loads should be considered, although they seldom have any effect on the design of the dam. In cases where the downstream water surface is relatively high, effects of radial cantilever sides should be considered in analysing effects of tail water pressure as well as in analysing effects of reservoir pressure.

If the dam is situated on a silt-bearing stream it may be necessary to consider the additional loads caused by silt deposits at the upstream face of the structure. This is particularly true in the case of a dam having an inclined upstream face. In such a case the weight of the silt acts vertically downward on the concrete, continuously, as long as the deposits are present. Increases in horizontal pressure at the upstream face of a high storage dam, caused by silt deposits, are seldom important because the silt consolidates within a relatively short time after its deposition,* so that the time of occurrence of such increases in horizontal pressure as may develop seldom synchronises with the passage of the maximum flood for which the dam is designed.

Temperature changes must, of course, be carefully considered in analysing arch deflections and stresses, in both preliminary and final trial load studies. Only the drops in temperature which occur after the radial contraction joints are grouted need be considered, inasmuch as rises in temperature tend to push the dam upstream, thus working against the water load. As a general rule maximum stresses in both arch and cantilever elements can be materially reduced by postponing the grouting operations until the setting heat is entirely dissipated and then grouting the joints late in the winter, when the concrete is approximately at its minimum seasonal temperature.

Usually, it will be desirable to make a new trial load analysis for maximum flood conditions as soon as the excavation of the base is completed, inasmuch as the limits of such excavation can never be accurately predicted in the preliminary designs.

In preparing a tentative design for an arch dam it will usually be found advisable to adopt a constant-angle type in the case of a V-shaped canyon having sides sloping upward on approximately equal slopes, and a constant-radius type, in the case of a comparatively wide U-shaped section where a relatively greater proportion of the total water load must be carried by cantilever action. However, local geological conditions, such as character of rock formations, extent of cracking, existence of fault zones, and so forth, may modify the decisions which otherwise would be made from the standpoint of the most desirable stress distribution.

A constant-angle design is one in which the radius of curvature is decreased as the depth below the top of the dam increases so as to secure approximately the same central angle at all elevations. A constant-radius design is one in which the central angle is decreased as the depth below the top increases so as to keep approximately the same radius of curvature at all elevations. Fig. 3, a plan of Cat Creek Dam near Hawthorne, Nevada, shows a typical constant-angle design. Fig. 4, a plan of Deadwood Dam near Boise, Idaho, shows a typical constant-radius design.

In the case of a constant-radius type it usually will be found advisable to increase the thickness of the arch elements as they approach the abutment locations, beginning the thickening either at the crown section or at the quarter points. In the case of a constant angle design the arch elements may either be thickened toward the abutments, or made concentric, depending on the conditions and dimensions at the particular dam site. Probably in both cases it will be desirable to provide short radius fillets at the downstream face of the dam, at the locations where the arch elements abut against the sides of the canyon. Provision of fillets along the downstream toe of the dam at the principal cantilever sections also will be desirable if the height of the structure is great enough to cause relatively high cantilever stresses.

Massive gravity sections, heavy enough to carry the total radial shear in the arch elements, may be needed at the ends of the arched section of the dam in cases where the abutment excavation cannot feasibly be made along radial lines, or along lines having a satisfactory degree of convergence toward the downstream face of the dam. A thrust block designed for radial shear loads, is shown at the right end of the arched section in Fig. 4.

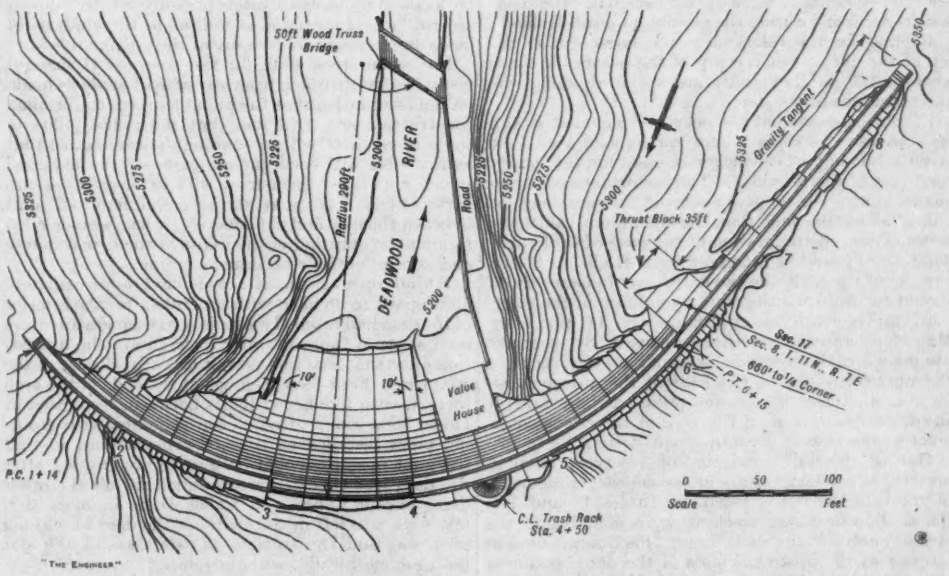


FIG. 4—CONSTANT RADIUS DESIGN—DEADWOOD DAM, IDAHO

Tentative designs for curved concrete dams are frequently based on computations of arch thickness by the cylinder formula, using a relatively low value of maximum allowable stress. However, experience has shown that designs prepared on such a basis must be materially modified when the stresses are analysed by the trial load method. Consequently, it seems much better to base the tentative plans on a careful study of actual dimensions of arch dams built at similar sites, where the dimensions and curvatures

* "Puddle Core Investigations at Tieton Dam, Washington," by Ivan E. Houk, *Eng. News-Rec.*, Sept. 30th, 1926, pages 544 to 547.

were logically determined by detailed trial load analyses.

Dams Designed by Trial Load Methods.

Tables II and III give the principal technical and dimensional data for fifteen curved concrete dams designed by the trial load method up to the present time. The dams are arranged in order of decreasing height, beginning with the 731ft. Boulder Dam on Colorado River near Las Vegas, Nevada, now being completed by the Bureau of Reclamation, United States Department of the Interior. The smallest included is the 118ft. Cat Creek Dam near Hawthorne, Nevada, completed by the Bureau of Yards and Docks, United States Navy Department, in 1932. On page 40 photographs of four of the dams included in these tables are reproduced.

Eight of the dams listed in the tables are constant-radius designs. The other seven are constant-angle types. Concentric, or constant width, arches were used in the Boulder Canyon, Owyhee, O'Shaughnessy, Camp Verde, Seminoe, Deadwood, Eleven Mile Canyon, and Cat Creek dams. Long radius, circular fillets were later added at the ends of some of the intrados curves at elevations where arch action predominates, in the case of Boulder Canyon, Deadwood, and Cat Creek dams; and relatively short, straight fillets, at the ends of some of the intrados curves in the case of Owyhee Dam. Widths of arch elements were gradually increased from the crown section to the abutments at practically all elevations in the Parker, Ariel, Gibson, and Taylor Park designs; and from about the quarter points to the abutments in the Calles and Stewart Mountain dams, the widths of the arches being kept practically constant from the quarter points to the crown in the latter structures. In the case of Horse Mesa Dam the arch widths were decreased gradually from the crown to the points of contraflexure, then increased gradually toward the abutments.*

Table II gives the location of each dam, year completed, purpose, type of design, maximum height above lowest foundation level, and corporate agencies responsible for the design and construction. Table III gives the principal dimensions, radii of curvature of top arches, basic assumptions for design purposes, and maximum stresses in both arch and cantilever elements under the principal conditions of loading.

In the case of the arch elements maximum stresses are given for both crown and abutment locations. All stresses are given in pounds per square inch. Cantilever stresses are acting in vertical, radial planes, in directions parallel to the slopes of the upstream and downstream faces of the dam. Arch stresses are acting in directions parallel to the extrados and intrados curves, and are horizontal stresses except where marked with a P, meaning principal stress. Principal stresses are inclined downward towards the abutments at angles varying with the shape of the canyon and dimensions of the dam. Arch and cantilever stresses are given for both upstream and downstream faces of the dam in the case of full reservoir loading; but cantilever stresses are given only for the location of maximum stress in the case of an empty reservoir. The term "full reservoir loading" is used to designate the conditions occurring during the maximum possible flood; that is, when the reservoir water surface is at the top of the dam, or at the top of the parapet in cases where solid parapet walls are specified along the upstream face of the dam.

Effects of earthquake shocks are included in full load stresses in cases where earthquake loads are given; but not in cantilever stresses for the empty condition of the reservoir. The importance of earthquake effects on empty reservoir stresses may be indicated by the fact that the maximum cantilever stress at the upstream edge of the base of O'Shaughnessy Dam would be increased from 413 lb. to 470 lb. per square inch if the assumed earthquake shock should occur during the empty condition of the reservoir, an increase of approximately 14 per cent. Maximum cantilever stresses caused by concrete weight when the reservoir is empty usually occur at the upstream edge of the base of the crown cantilever in the case of constant radius designs, and at the downstream edge of the base of the crown cantilever in the case of constant angle designs.

During the full condition of reservoir loading, horizontal cracking occurs in the cantilever elements of most of the dams listed in Tables II and III. Since allowances for cracking were included in the stress analyses in such cases, maximum tension stresses at the upstream faces of the dam, assuming no cracking to occur, are not available, and cannot be given in the tabulations. Cracked conditions are designated by the letter C in the column for maximum upstream cantilever stress under full load. Maximum cantilever compressive stresses at the upstream face of the dam during full reservoir load are given for Boulder Canyon, Owyhee, O'Shaughnessy, and Parker dams, since in these cases relatively high compressive stresses occur at the upstream face at or near the base of the maximum cross section. The minimum compressive stress at the lower elevations of the upstream face during full reservoir load is given in the case of Seminoe Dam, where cracking was eliminated by specifying the grouting of the radial construction joints when the concrete temperatures are 10 deg. Fah. below ultimate mean annual values.

Maximum arch stresses at extrados and intrados locations are not necessarily at the same elevations, at either crown or abutment sections. Consequently, the estimated maximum compressive stresses for cracked conditions are not necessarily the sums of the maximum tensile and compressive stresses given in the tabulations.

Effects of ice pressure are not included in the maximum full load stresses in cases where ice loads are given, since such loads do not occur during maximum flood conditions. In each case where effects of ice loads were analysed the surface of the ice was so far below the top of the dam that the maximum stresses caused by ice pressures, combined with the accompanying partial-depth water pressures, were lower than those existing during full reservoir loading.

The maximum stresses given in Table III are not strictly comparable in all cases. For instance, tangential shear and twist effects were not included in the trial load analyses of Horse Mesa, Calles, Stewart Mountain, and Gibson dams. Furthermore, some modifications of calculation methods were adopted as the development of the trial load analyses progressed, and in most cases the earlier studies were not revised to include the effects of such modifications. Abutment stresses at the Deadwood, Eleven-Mile Canyon, and Cat Creek dams include effects of concentrated cantilever loads which were later eliminated from the calculations of arch stresses, and included in the calculations of principal stresses. Consequently, the abutment arch stresses at those dams are somewhat higher than they otherwise would have been, although not greatly higher than the principal stresses would have been if they had been computed.

In the column headed "Uplift assumption" the designations "0·67 uplift" and "0·5 uplift" mean that an uplift pressure curve varying as a straight line from full reservoir pressure at the upstream face of the dam to zero or tail water pressure at the downstream face, was applied to two-thirds or one-half the horizontal areas, respectively, except in the case of Owyhee Dam. At Owyhee Dam an uplift pressure curve varying as a straight line from full reservoir pressure at the upstream face of the dam to one-half of reservoir pressure at the location of the vertical drains, then to zero, or tail water, pressure at the downstream face, was applied to the full horizontal area, an assumption which has almost the same effect as the two-thirds uplift assumption.

In the case of Parker Dam two unusual considerations were involved in the technical design—first, the fact that in order to provide adequate spillway capacity during times of extreme flood flow, it was necessary to specify five 50ft. by 50ft. Stoney gates for installation on the spillway crest; and, secondly, the fact that owing to an accumulation of sand, gravel, and boulder deposits in the bottom of the canyon, a 230ft. minimum depth of backwater will be present at the downstream face of the structure at all times. The latter consideration required inclusion of radial cantilever effects in the analysis of loads due to backwater pressure at the downstream face of the dam as well as in the analysis of loads due to reservoir pressure at the upstream face.

Maximum stress data for the enlarged O'Shaughnessy Dam were taken from a trial load analysis made on the assumption that the radial joints in the original construction are tight and that the radial joints in the new concrete will be thoroughly grouted, so that arch action will occur in all parts of the enlarged structure. It is understood that in order to secure better stress conditions at the circumferential joint between the new and old concrete, it has been decided to omit the grouting of the joints in the new concrete and depend entirely on gravity action.

Radial open slots, 2ft. wide and approximately 30ft. apart, to be filled with concrete after the interior of the dam had reached mean annual temperature were used at Ariel Dam, in order to facilitate the dissipation of setting heat and permit an early closure of the structure. Four-foot openings at the ends of the arch section, with five keyed joints between, were used at Horse Mesa Dam. Radial, keyed joints, with grouting pipes installed at time of construction, so that the joint openings could be thoroughly grouted after the dam had cooled, were specified for all the other dams except Calles. At Calles Dam an open slot, 6ft. wide, was left in the centre of the dam for closing purposes, and the sections at the sides of the slot built monolithically, without joints.*

Approximate concrete temperatures at time of grouting joints, or filling slots, are given in Table III, whenever possible. It will be noticed that in some of the more recent designs the values given are below mean annual temperatures. In the case of Seminoe Dam, a contemplated development in the Seminoe Mountains of Wyoming, the tentative designs specify grouting the construction joints when the concrete temperatures are 10 deg. Fah. below mean annual.

Beneficial effects on stress magnitude and distribution are secured if the closure is made at as low a concrete temperature as possible. This is because the upstream movement which tends to take place as the temperature rises after the closure is made, partially balances the reservoir water pressure, and thus tends to reduce the deflections and stresses during full load operation. In the trial load analyses of Seminoe Dam for the full condition of the reservoir, including earthquake effects, a reduction of 10 deg. in concrete temperature at time of grouting construction joints showed important reductions in both arch and cantilever stresses. In the case of the arch elements, the tension stresses were reduced as much as 261 lb. per square inch at the upstream face at the abutments, and as much as 209 lb. per square inch at the downstream face at the crown, the latter being a change from 150 lb. per square inch tension to 59 lb. per square inch compression. The arch compression stresses were reduced as much as 169 lb. per square inch at the downstream face at the abutments, and as much as 95 lb. per square inch at the upstream face at the crown. In the case of the cantilever elements the maximum inclined stress at the downstream edge of the base of the crown cantilever was reduced from 746 lb. to 468 lb. per square inch, a reduction of 278 lb. per square inch, or approximately 37 per cent.

An inspection of the data in Table III shows that a normal stress of 700 lb. per square inch, approximately 50 tons per square foot, is exceeded in the Ariel, Horse Mesa, and Calles dams; and a normal stress of 600 lb. per square inch, approximately 43 tons per square foot, in the Owyhee, Camp Verde, Ariel, Horse Mesa, Calles, Stewart Mountain, and Gibson dams. The maximum arch stress given in the tabulations is the intrados compression of 743 lb. per square inch, 53·5 tons per square foot, near the abutments of Horse Mesa Dam, estimated on the assumption that the calculated arch tension is relieved by cracking of the concrete or by opening of the radial construction joints. The maximum cantilever stress given in the tabulation is the downstream base compression of 950 lb. per square inch, 68·4 tons per square foot, given for the 219ft. Calles Dam in Mexico.*

Recent trial load analyses show that the maximum cantilever stresses of 516 lb. and 565 lb. per square inch, approximately 37 and 41 tons per square foot, at the upstream and downstream faces of Boulder Dam during the empty and full conditions of the reservoir, may be increased about 24 and 18 per cent. respectively, when proper allowances are made for the true non-linear distribution of stress between the two faces of the dam. Arch stresses in Boulder Dam are being greatly benefited by cooling the concrete and grouting the radial construction joints when the temperatures in the interior of the dam are below the ultimate mean annual values.

Maximum principal stresses at the upstream and downstream faces of the dam at the abutments are given for the Boulder, O'Shaughnessy, Parker, Seminoe, and Taylor Park dams, tension stresses at extrados locations being indicated by the minus sign. Maximum principal compression stresses estimated on the assumption that no load is transferred by tension are not given. Such stresses cannot be estimated by adding compression and tension stresses at the upstream and downstream faces of the dam at the same elevation, as in the arch analyses, since the principal stresses are not acting in the same directions at the two locations.

Maximum shearing stresses in arch and cantilever elements are given for Boulder, O'Shaughnessy, Parker, Seminoe, and Taylor Park dams. All of the values given are based on the assumption of a straight line distribution of direct stress. Trial load analyses of effects of non-linear distribution of stress show that the values given for Boulder Dam may be increased about 37 per cent. in the case of the cantilever elements and about 30 per cent. in the case of the arch elements.

The maximum shearing stress is usually about three-halves the average shearing stress in the case of the arch elements, but may be as much as twice the average shearing stress in the case of the cantilever elements. Maximum shearing stresses usually occur at the downstream edge of the base in cantilever sections of approximately triangular shape, having continuous straight line slopes at the downstream face; but may occur in the interior of the base if the cross section is of rectangular shape, or has a convex downstream slope approaching a vertical direction near the foundation level. Calculations of maximum cantilever shearing stresses are further complicated by the radial sides of the cantilever elements. Maximum shearing stresses in radial sections of arch elements usually occur near the center of the arches at the abutments, in the case of concentric extrados and intrados curves, but may occur at other depths from the faces if the arches are thickened towards the canyon walls. Shearing stresses become zero at the crown section in the case of a symmetrical dam symmetrically loaded.

Acknowledgments.

The above discussions are based on technical investigations of curved concrete dams made under the writer's direction during the eleven years since the development of the trial load method of analysis was begun in the Denver office of the Bureau of

* "Salt River Project, Arizona, Part II, Horse Mesa Dam," by T. A. Hayden, *West. Constr. News*, July 10th, 1930, page 320.

* Information courtesy Ing. Adolfo Orive Alba.

* For general data on Calles Dam see "A Modern Mexican Irrigation Development," by A. M. Valdes, *Civil Eng.*, Aug., 1931, pages 1009 to 1014.

Reclamation. Although the investigations included some studies of nearly all the dams listed in Tables II and III, most of the research work was done in connection with the design and construction of the 731ft. Boulder Dam on the Colorado River, near Las Vegas, Nevada. Bureau of Reclamation dams are designed under the general direction of J. L. Savage, chief designing engineer, and all engineering and construction activities of the Bureau are under the general supervision of R. F. Walter, chief engineer, with headquarters at Denver, Colorado. All activities of the Bureau are under the supervision of Dr. Elwood Mead, Commissioner, with headquarters at Washington, D.C.

The North-East Coast Institution of Engineers and Shipbuilders.

TO celebrate the first half-century of its existence the North-East Coast Institution of Engineers and Shipbuilders has arranged a jubilee meeting in Newcastle-upon-Tyne from July 16th to 19th. The programme includes a thanksgiving service in St. Thomas's Church, Newcastle-upon-Tyne, conducted by the Right Rev. Lord Bishop of Newcastle, a civic reception, meetings at which papers will be read and honorary fellowships conferred, and a banquet and dance, as well as other social gatherings and excursions usual and suitable to a festive occasion.

In the *Daily Telegraph* of April 15th, 1935, the Right Hon. Walter Runciman, reviewing briefly the Tyne and its industries, wrote as follows: "My memory goes back to the 'seventies and 'eighties, when the gloom of conditions similar to the present, though different in form, hung over deserted yards and docks and ships. If the men of that day had given up in despair or succumbed to the harsh commercial forces which almost exterminated many of our great concerns of those days, we should never have seen the glorious recovery of the 'nineties and the first decade of this century. Enterprise, invention, and skill enabled us to overcome our misfortune and embark upon many new undertakings." Among these undertakings was the founding of the North-East Coast Institution of Engineers and Shipbuilders. Adversity has its uses; this body is now one of the leading technical associations in the kingdom, its membership extends to, and its "Transactions" are in demand throughout the world, wherever ships are built. A brief account of its inception and of some of the work it has accomplished in the past half-century may therefore interest our readers.

On March 17th, 1884, a letter appeared in the *Newcastle Daily Journal*, suggesting the formation of an institution similar to the Institution of Engineers and Shipbuilders in Scotland. This letter, over the *nom de plume* of "T. Square," was written by Mr. W. G. Spence, who later, and until his retirement a few years ago, was a director and general manager of George Clark, Ltd., of Sunderland. On the following day the *Journal* contained another letter from the pen of the late Mr. William Boyd, for many years the managing director of the Wallsend Slipway and Engineering Works, Wallsend-upon-Tyne, heartily endorsing the idea. During the summer of 1884 a group of nine young men, with Mr. Spence as secretary, formed themselves into a provisional committee, held meetings, and issued circulars to the heads of the drawing-offices in the various shipbuilding yards and marine engineering works on the Tyne, asking them to canvass their staffs and report as to prospective membership, &c. While these activities were in progress Mr. Boyd was using his influence with the owners of works and others to secure their support for the enterprise. The replies were considered sufficiently encouraging to warrant the calling of a public meeting, and this was held in the Surgeons' Hall, Newcastle-upon-Tyne on October 8th, 1884, Mr. C. W. Hutchinson occupying the chair.

At a further public meeting on October 22nd, which was attended by several prominent engineers and shipbuilders, with Mr. Boyd in the chair, arrangements were made for the formation of an institution and for the election of a council. The election resulted in Mr. Boyd being appointed as president and Mr. Spence as honorary secretary.

The Institution has been fortunate in securing presidents who, besides being engineers or shipbuilders of distinction, have always given unstinted time and labour during their terms of office, and much of the success obtained is due to this fact. The president for the current year is Mr. John T. Batey.

To attempt a detailed account of the work of the Institution would be outside the scope of this short description. A general, if superficial, survey may, however, be of interest to our readers. It should first be observed that the reading and discussion of technical papers is one part only of the useful activities of the Institution. The first paper contributed to the "Transactions" was from the pen of Mr. (later Sir) William H. White, K.C.B., on "The Speed Trials of Steamships." The reading of this paper resulted in consideration being given to the position and character of the then existing measured mile at Whitley and its re-establishment in a position further north of the Tyne, as suggested by Mr. White. New and higher mile posts were erected north of Whitley, and these in their turn were, some years later, replaced by steel lattice masts of still greater height. The Institution was appointed the custodian of the mile posts, which are inspected from time to time by a committee, the cost of maintenance being defrayed by the Shipbuilding and Engineering Employers' Associations.

In perusing the record of the several hundred papers read before the Institution one is impressed by the fact that all fields of advance in marine engineering and shipbuilding during the past half-century appear to have been adequately covered and also by a definite and progressive rise in the quality of the papers and the discussions. Much of this improvement in quality has undoubtedly been due to the wider spread of higher technical training. When the Institution was founded the triple-expansion engine was just being introduced, and in the first session a paper describing this novel development was presented by the late Alexander Taylor, whose name, together with that of Dr. Kirk, is indelibly associated with this improvement. Such questions as mechanically forced draught for combustion, liquid fuel, and electric lighting in ships were then in their infancy; and the application of power by electric drive or compressed air, either ashore or afloat, was practically non-existent. In the earlier sessions each of these subjects received due attention. In December, 1887, the Hon. C. A. Parsons (later Sir C. A. Parsons, O.M., K.C.B., F.R.S.) contributed a paper on "The Compound Steam Turbine and its Theory as Applied to the Working of Dynamo-electric Machines." The developments which followed on this contribution to engineering science are known to all the world. In 1890 a meeting was convened of the graduate members of the Institution, which resulted in the formation of a graduate section for the reading and discussion of papers, the late Frank T. Marshall being the first president of the section. This has formed an admirable training ground for the younger members of the Institution, and prizes are annually awarded by the Council for the best papers submitted by graduates. Some of these, of exceptional merit in the opinion of the Council, have been published in the "Transactions." About the same time a fund was raised to provide a gold medal to be awarded annually to the author of the best paper read before the Institution, the condition being attached that such a paper should reach the high standard of quality that, in the opinion of the Council, is required, a stipulation which is carefully and judicially observed.

From its early days the Institution has given full consideration to the question of the education and training of engineers and shipbuilders. In February, 1886, the Council of the Durham College of Science (later the Armstrong College) gave to the Institution the right to nominate one member of the Council of the College, at the time housed in a small building in unsuitable surroundings. In October of the same year the then Principal of the College (Dr. Garnett) suggested to the president of the Institution the convening of a conference of engineers and shipbuilders for the purpose of discussing the desirability of provision being made for instruction at the College in marine engineering and shipbuilding, and, if found to be desirable, the nature and organisation of such teaching. This conference took place in Newcastle-upon-Tyne on December 18th, 1886, when it was unanimously agreed that a Chair of Naval Architecture and Marine Engineering should be founded and provision made in the new College, then about to be built, for adequate instruction in these subjects. Later the Council of the Institution nominated Mr. R. L. Weighton, M.A., as the first professor; he was duly appointed to the chair by the College Council and filled it for many years with distinction and to the great advantage of the industry.

Among the papers on the subject of technical education which have appeared in the "Transactions," the first, and one which exercised considerable influence on the education of engineers and shipbuilders, was completed by its author, Ivan Mavor, just before his tragic death by accident on December 26th, 1886. Another of great interest at the time was the late Max Wurl's "Technical Education in Germany" (1903); this and the report of the discussion contain a valuable summary of the methods of training developed in Germany and in our country respectively at the beginning of the century. In the same year, during the presidency of the late John Tweedy, who gave much attention to this question, the Educational Committee of the Institution issued a report recommending the adoption in engine works of a scheme for recording and remunerating the time-keeping, conduct, and class work of apprentices, and for the enlistment and remuneration of specially selected pupils. The scheme was based on a somewhat similar arrangement which had been introduced in 1902 by the late D. B. Morison in the engine works of Messrs. Thos. Richardson and Co., Hartlepool.

These recommendations were adopted by several North-East Coast firms, and in 1907 a paper entitled "Notes from Four Years' Working of the Educational Committee's Recommendations" was read, which showed by graphs and deductions therefrom the need of and the advantages derived from the scheme. Other papers on the subject of education include Professor R. J. Welch's "The Scientific Education of Naval Architects" (1908–9), and Principal V. A. Mundella's "The Education of Youths Before and During their Apprenticeship" (1915–16).

In 1916 a special committee was appointed to consider the education of apprentices, and its valuable and authoritative report, issued and approved by the Council in June, 1917, was also adopted by the Newcastle-upon-Tyne Education Committee and the Sunderland Education Committee. On October 18th of the same year a deputation from the Institution, together with representatives from the Newcastle-upon-Tyne Education Committee, Armstrong College, Sunderland Technical College, and the various employers' associations, under the leadership of his Grace the Duke of Northumberland, waited on the then President of the Board of Education (the Right Hon. H. A. L. Fisher), and laid before him the Institution's views and suggestions. The most recent outcome of the Institution's educational activities was the issue in February, 1930, of a report on "Engineering Training for Officers' Rank," prepared by a special committee. This is a very valuable and exhaustive report and deserves careful consideration by the directors and managers of works and all interested in the training and supply of men to occupy responsible positions in the future. It is unfortunate that its issue coincided with a period of unparalleled trade depression; but that is, in fact, an additional reason for its serious consideration. The report should be in the hands of parents, schoolmasters, and all responsible for the selection and preparation of the material to be trained. Incidentally, it may be suggested that the title of the report may be somewhat confusing to the general public.

In 1907 a fund was raised to establish a scholarship, tenable for three years, awarded annually as the result of a competitive examination of graduates. The provision of an additional scholarship has recently been made possible by the generous gift of Mr. George Mitchell Harroway. A fund also exists called the Thomas Fenwick Reed Fund for the occasional award of a medal to the candidate who most successfully produces and exhibits evidence of "ability to share in the control of industry"—a somewhat difficult quality to assess. A fund to award an additional medal which shall be open to non-members has recently been given by the sons of the late M. C. James, who, from its foundation, took a keen interest in the Institution.

In 1892 the late J. Denholm Young read a paper on "A System of Mechanical Aid to the Investigation of Speed Curves." This was followed in the next session by one by the late Wilhelm Hök, "On a Method of Comparing Steamship Performances and of Estimating Powers and Speeds of Ships." The reading and discussion of these two very able papers had a considerable influence in convincing engineers and shipbuilders of the importance of "progressive speed" trials earlier advocated by Dr. John Inglis and Mr. William Denny. They pointed the way to more scientific methods of recording and using the data so obtained, based upon the fundamental laws of comparison and similarity enunciated by Newton and Reech and rediscovered and applied by Froude in connection with his classical tank experiments.

In 1896 Professor R. L. Weighton contributed a paper on the experimental engines at the Durham College of Science, Newcastle-upon-Tyne, and the results obtained from them. One of the results referred to indicated that the ratios of expansion then usual in practice could be reduced without decrease in efficiency; in short, that from a heat economy point of view, engines for given powers were being designed larger than they need be. This view was an apparent contradiction to the generally accepted theory of economy in number of expansions. Within suitable limits the effect of this "result" is appreciated to-day, but at the time it was looked upon as revolutionary.

The then unsatisfactory condition of the Engineer Branch of the Royal Navy was the subject of the careful attention of the Institution about the end of the nineteenth and early in the present century. In 1900 the late D. B. Morison, who had gone very closely into the matter, contributed a paper on "The British Naval Engineer, his Present Position and Influence on our Sea Power"; as a result of this contribution and its discussion, a committee was formed to collaborate with other engineering institutions with the view to drawing up a report for submission to the Government. In July, 1901, a deputation, constituted of Members of the House of Commons with Mr. Morison and representatives from the North-East Coast and other engineering institutions, waited on the then First Lord of the Admiralty (Lord Selborne), to whom they submitted

an exhaustive memorandum recording "their opinion that the present constitution and organisation of the Engineer Branch of the Royal Navy does not admit of it efficiently fulfilling its important functions." The history of what followed is too long to enter into here, but Mr. Morison and his friends showed great persistence, and, as is well known, improvements were eventually effected.

At the beginning of the present century, the question of the adoption of electricity for the transmission of power was receiving much attention, and in 1904 a paper on the "Application of Electricity to Industrial Purposes" was read by Mr. (later Sir) John F. C. Snell. The introduction of the internal combustion engine for marine propulsion provided a wide field for discussion. In 1910 the first paper on this subject was submitted; many others have followed, and in the session of 1922–23 no fewer than four papers dealing with various aspects of the subject were read.

An interesting feature of the Institution's meetings has been the reading and simultaneous discussion of several papers by different authors on a single subject or cognate subjects; a species of technical "symposium." The first of these meetings was in the session of 1911–12, when four contributions on "Relative Possibilities of the Diesel Oil Engine, Geared Turbine, and Suction Gas Engine as Compared with the Reciprocating Engine for Marine Propulsion," were presented by E. L. Orde, Sir Charles A. Parsons, R. J. Walker, and A. C. Holzapfel respectively. In 1922–23 a "Review" of different types of marine internal combustion engines produced a series of papers contributed by the manufacturers of a number of different engines as follows:—

"Armstrong-Sulzer," by Armstrong Whitworth and Co., Ltd.

"Doxford," by William Doxford and Sons, Ltd.

"Camellaird-Fullagar," by Cammell Laird and Co., Ltd., and Palmers Shipbuilding and Iron Company, Ltd.

"Neptune," by Swan, Hunter and Wigham Richardson, Ltd.

"Scott-Still," by Scott's Shipbuilding and Engineering Company, Ltd.

"Vickers," by Vickers, Ltd.

"Werkspoor," by Hawthorn Leslie and Co., Ltd.

Each paper represented the respective engine builders' proposals for a set of internal combustion engines fulfilling the conditions laid down in a specification drawn up by the Council of the Institution.

In 1931–32 the subject for a symposium was "Improved Marine Reciprocating Engines: Does their Performance Justify their Extra Cost?" the papers being:

(*a*) "Introduction," by J. N. Hendry.

(*b*) "Beardmore Poppet Valve Engines with Caprotti Valve Gear," by William Beardmore and Co.

(*c*) "The Christiansen Engine," by Christiansen and Meyer, Harburg, Germany.

(*d*) "The Lentz Engine," by John Dickinson and Sons, Ltd., Sunderland.

(*e*) "Superheated Marine Steam Reciprocating Engines," by the North-Eastern Marine Engineering Company, Ltd.

(*f*) "Contribution," by the Wallsend Slipway and Engineering Company, Ltd.

In the session 1933–34 "The Possibilities of Applying Improvements Effected in Modern Land Power Plant to Ship-Propelling Machinery" was dealt with by W. T. Bottomley, E. W. Corlett, and Frank Piercy.

The foregoing sketch is intended merely to indicate the wide range of the Institution's activities even in its early days, and the particular papers to which reference has been made have been selected as examples of records of research or fundamental investigations that have definitely influenced practice.

In 1931 the sisters of the late Mr. Andrew Laing gave a sum of money for the purpose of establishing an "Andrew Laing Memorial Fund," the income of which is to provide a lecture to be given annually on engineering or shipbuilding. The Institution owes much to the continued interest taken in it during his lifetime by the late Sir Charles A. Parsons, and at his death he bequeathed to it a sum of £4000 free of all conditions.

Translations of some of the papers read before the Institution have been published in French, German, and Italian, and a pleasing feature evidenced in recent years is the growth of co-operation of foreign members in the work of the Institution and the increase in the number of papers contributed by them.

The Institution renders service in many directions through its official representatives on such bodies as the Consultative Committee of the Board of Trade, Lloyds Technical Committee, the Committee of the British Corporation for the Survey and Registry of Shipping, the William Froude National Tank, and various committees of the British Standards Institution, &c.

The Institution, whose Patron is his Majesty the King, was incorporated in 1914, and the present Secretary is Mr. E. W. Frazer-Smith, M.A. From the foregoing it will be seen that it has a record of fifty years' work of no small importance. Its usefulness and activities have steadily grown from relatively small beginnings, and from being, in its inception, a technical and scientific organisation of local or district importance, it has now achieved in some measure an influence which extends far beyond the shipbuilding industry of the North of England, and is, in fact, almost national in its character.

The Royal Agricultural Show at Newcastle-upon-Tyne.

No. III.

(*Concluded from page 10, July 5th.*)

THE prejudice which formerly existed amongst dairy farmers against mechanical milking is fast disappearing. Much of their reluctance to install machinery for this purpose was the outcome of the bad keeping quality of the milk so produced owing to the difficulty of maintaining the complicated mechanism thoroughly clean. In modern machines this defect has been abolished, and the milk now extracted by mechanical means is equal to, if not superior to, that obtained by hand milking as regards the hygienic quality. Generally, the operation of modern milking machines depends upon a combination of suction, pressure, and release, resembling the sucking of a calf. There are certain difficulties in the construction of the teat cups and the milk pails as well as in the speed of pulsation, method of control, dismantling and assembling. The machines exhibited are broadly divisible into two kinds: (1) those in which the milk from each cow is collected in a bucket placed beside the animal, and (2) those in which the milk from a number of cows is conveyed into a milk churn. The former type is the more popular and is installed in cow byres, while the latter is used with portable plants operating in the open air. As a rule, however, it has been found that machine milking is only a paying proposition with herds of thirty cows or more.

Besides milking machinery up-to-date dairy farmers now require mechanism for recording the quantity and quality of the milk produced by each cow. A plant for this purpose was exhibited by Gascoignes, Reading. In the dairy plant section, Aveling-Barford, Ltd., Grantham, had a very comprehensive display of sterilising outfits, milk-cooling plants, pasteurisers, bottle-washing and filling machines. For cooling and cold storage purposes there were shown Ethylor plants and a "Methylor" air-cooled unit operating a cold chamber of 100 cubic feet capacity. The Ethylor sets are designed for belt driving, but the Methylor set was shown in operation, power being provided by an electric motor. These plants are self-contained and instantaneous in operation. The D.B. Engineering Company, an offshoot of the well-known textile machinery manufacturers, Dronsfield Brothers, Oldham, showed a hand-operated pneumatic milking plant capable of dealing with two cows simultaneously. This is a handy portable plant embracing two containers and a hand-operated pump. The degree of vacuum obtainable by this plant can be regulated to suit the conditions. The machine is easy to fix, work, and operate, and should meet the needs of dairy farmers with only a few animals.

The Alfa Laval Company, Ltd., Brentford, was one of the earliest firms to supply milking machines. At Newcastle it had an interesting stand comprising every appliance needed in the dairy, including a combined recorder milking machine, which automatically milks, weighs, inspects, conveys, and releases the liquid.

International Harvester Company.

The International Harvester Company of Great Britain, Ltd., had one of the most extensive displays of farming implements and tractors in the showyard. These included binders, mowers, ploughs, cultivators, thrashing machines, harvester thrashers, and milking machinery. The most interesting exhibit to us was the McCormick-Deering trac-tractor, the power unit of which is a four-cylinder vertical compression ignition engine, capable of developing over 50 h.p. The interesting feature of this engine is that it can be started by hand cranking as readily as a petrol engine. This is effected by constructing the engine so that in starting the C.I. features are inoperative and are replaced by a carburetter, magneto, and the usual valve arrangement for four-stroke petrol engines. The essential parts of the engine, namely, the housing, pistons, crank shaft, manifolding, cooling, and lubricating systems, are common to both starting and compression ignition operations. This method of construction is specially advantageous for cold weather starting, all the operating parts being warmed up before the engine commences to operate on the C.I. principle. Another feature of this original system is that the change-over to Diesel operation is performed automatically after the engine has made a predetermined number of revolutions and is operating at the proper speed. This method of starting ensures the full heat of the compressed air to give a "snappy" start.

The accompanying sectional illustrations—Figs. 12

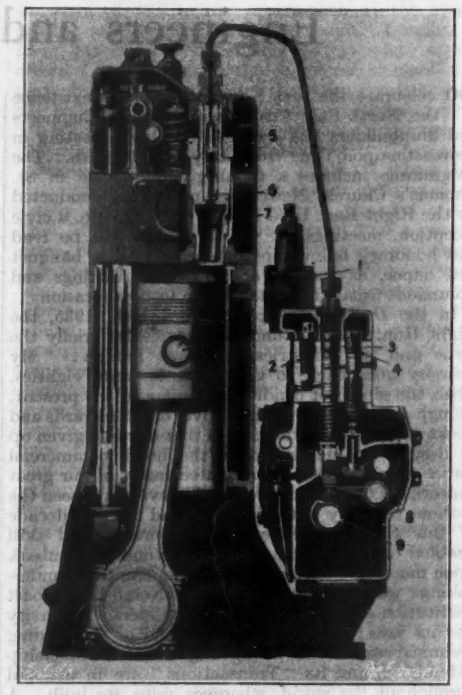


FIG. 12—SECTION THROUGH 50 H.P. ENGINE—INTERNATIONAL HARVESTER

and 13—will enable our readers to understand how these features are combined in the one engine. In these sectional views, 1 is the oil supply pump for C.I. operation; 2, 3, and 4 are the parts of the injection pump system; 9 is the cam which actuates the plunger 3 and delivers a measured charge of oil through the fifth and final fuel filter 5 to the injector nozzle 6, which forces and converts the oil into a spray in the precombustion chamber 7. In starting the engine the operator turns the crank 10, which opens the valves 11 to the auxiliary combustion chambers 12. This added space to the cylinders reduces the compression pressure. The sparking plugs 13 are placed in these chambers. When the crank 10 is turned by hand the double

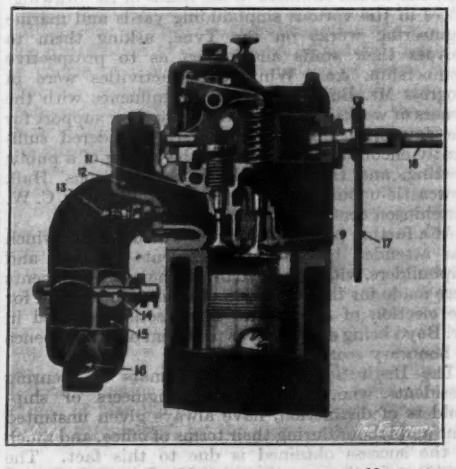


FIG. 13—SECTION THROUGH CYLINDER HEAD OF 50 H.P. ENGINE—INTERNATIONAL HARVESTER

butterfly valve 14 is operated so as to give free communication between the intake manifold 15 and the petrol carburetter connected at 16. The high-tension magneto supplying current to the sparking plugs is also simultaneously engaged. After the engine has made about 700 revolutions, the rod 17 releases the shaft turned by the crank 10, and when released the valve 11 is closed by a spring, thus cutting out the auxiliary combustion chambers, and isolating the sparking plugs. The same operation disengages the magneto and turns the double butterfly valve 14. The engine then proceeds to operate on the compression ignition principle. The cylinder head, containing the intake and exhaust valves, rocker arm shaft, valve springs, starting valves, and

precombustion chamber, is readily removable for valve grinding or any other purpose. The head is a one-piece annealed alloy casting to withstand the high pressures with minimum weight. The head is designed to cool the valves, fuel injection nozzles, and precombustion chambers. The fuel injection nozzles are assembled as units and then inserted in the cylinder head. Should the nozzles require attention at any time they can be removed and replaced, eliminating field adjustments. The overhead valves are silchrome steel and of generous size.

The fuel injection pump screens the fuel, accurately measures the amount to be injected, and then supplies pressure to spray the fuel as it is forced into the precombustion chamber. A sensitive governor of the fly-ball type is built integrally with the fuel pump. The governor controls the point of the by-pass valve opening, assuring immediate engine response to any load variation. All reciprocating parts of the pumps are made of Nitralloy metal hardened to 1100 Brinell test. All other parts, including the valves and valve parts, are of stainless steel. The pump body is "Parkerised," a process to prevent rusting and corrosion. Special precision machines are employed in machining the pump parts, which are kept within a tolerance of one ten-thousandth of an inch. This close tolerance requirement enables the pump parts to work under 5000 lb. pressure without the use of pump packing.

ALFRED HERBERT, LTD.

Taylor's "feed right" weighing and rationing machine illustrated in Fig. 15 was shown for the first time by Alfred Herbert, Ltd., Coventry.

This machine is the outcome of a series of careful tests by the patentee over a period of six years. Designed for the accurate rationing of concentrates by weight for dairy cows, pigs, or any dry-fed animals, it combines a convenient feed truck with weighing apparatus on the spring balance principle. The food compartment has a capacity for approximately 4 cwt. of average compound cake; to the left-hand side of the main food compartment is the weighing apparatus. Beneath the weight dial a frame is fixed for the ration sheet, which gives the names of the various animals and their rations. This sheet is

FIG. 15—WEIGHING AND RATIONING MACHINE—HERBERT

covered by a sliding celluloid protector, and enables the operator to see at a glance the food weight required. The weigh-box is filled through the hopper with a bowl or other similar dry-food scoop, and the weight of food is instantly registered on the graduated dial by a movable indicator working from the spring balance of the weigh-box. The weigh-box is then removed by the operator, carried by the handle and emptied into the manger.

CLARKE, CHAPMAN, AND CO.

On the stand of this Gateshead firm we noted a compact electrical generating set driven by a Lister cold-starting, crude oil engine. These sets are suitable for small and medium-sized lighting plants, and the engine is adequately silenced. The generator is of the makers' protected, end-shield bearing type, and is coupled to the engine by a flexible coupling. The machines can be supplied either compound or shunt wound as desired, and in the case of battery-charging plants a starting winding can be provided to allow the engine to be started from the battery if desired, thus saving hand starting.

Clarke, Chapman and Co. also exhibited the "Fire-fly" fire pump, illustrated by Fig. 16. This appliance was built by E. N. Mackley and Co., Gateshead-on-Tyne, and embodies a single-stage centrifugal pump, which is driven by a four-cylinder Ford petrol engine. When running at 3400 r.p.m. and discharging through 50ft. of canvas hose with a suction lift of 10ft., the pump will deliver 150 gallons of water per minute, and will give a $\frac{7}{8}$in. jet of 140ft. extreme height. At a speed of 2200 revolutions, the pump will deliver through a $\frac{1}{4}$in. jet 10 gallons per minute to an extreme height of 50ft. The engine, pump, exhauster, petrol and water tanks are arranged in a steel frame which can be readily removed from the main chassis, thus enabling the pumping unit to be carried over very rough ground or in confined spaces. The engine is cooled from an overhead tank until priming is effected, and then directly from the pump. The exhauster has solid bronze internal parts, and is fitted above the pump. It is driven by a friction wheel operated either by hand or foot. It is capable of priming a $3\frac{1}{2}$in. suction hose at the rate of 1ft. per second. Hinged covers and a streamlined bonnet give to the set a pleasing appearance. The Mackley pump was also shown, driven directly by an electric motor, suitable for pumping milk. For this purpose the pump is made of special non-corrosive metal, and has a cover which is secured to the casing by means of a coarse screw thread for easy removal.

FORD MOTOR COMPANY.

The Ford Motor Company's attractive stand contained, besides Fordson tractors for various purposes, a selection of implements suitable for use with them, as well as trucks for transport on the farm. Among the several different models of the Fordson tractor was one equipped with the latest Firestone "ground-grip" low-pressure pneumatic tires. This tire has a heavy tread of special design, and is

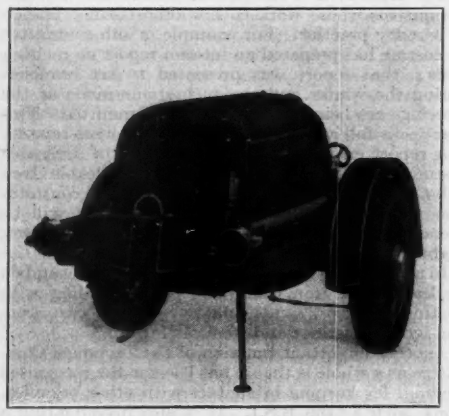


FIG. 16—"FIREFLY" FIRE PUMP—MACKLEY

claimed to be exceptionally efficient on grassland. The Fordson tractor, with McDowell crawler equipment, was also of interest, the wide-track type shown having been developed to suit English conditions. The Fordson golf course tractor, with low-pressure pneumatic tires and special light wheels to avoid damage to the fairways, and the standard Fordson agricultural model—Fig. 14—with cleats or spade lugs, completed this side of the display. A number of important design improvements have been made to the Fordson since last year, and an engine governor is now a standard fitting.

MARSHALL, SONS AND CO.

This firm's exhibits included an 18–30 b.h.p. oil-engined tractor of the agricultural type, a steel

FIG. 18—TWO-TON ROLLER—MARSHALL

frame 4ft. 6in. thrashing machine, a Clayton wooden-framed thrasher, and two motor-driven road rollers, one of 6 tons and the other of 2 tons weight. The light roller, shown in Fig. 18, is intended chiefly for footpath rolling and for working in a confined space.

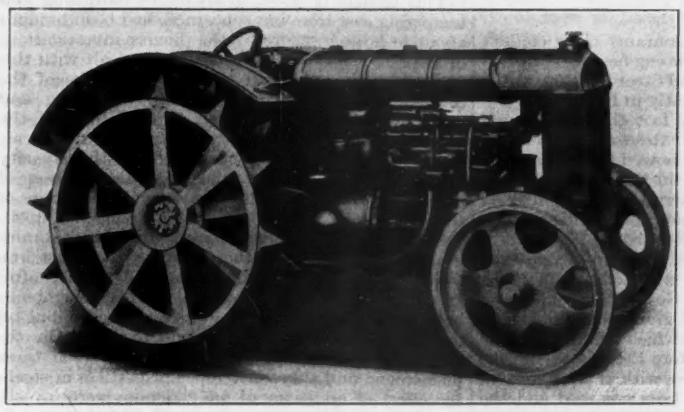


FIG. 14—FORDSON TRACTOR

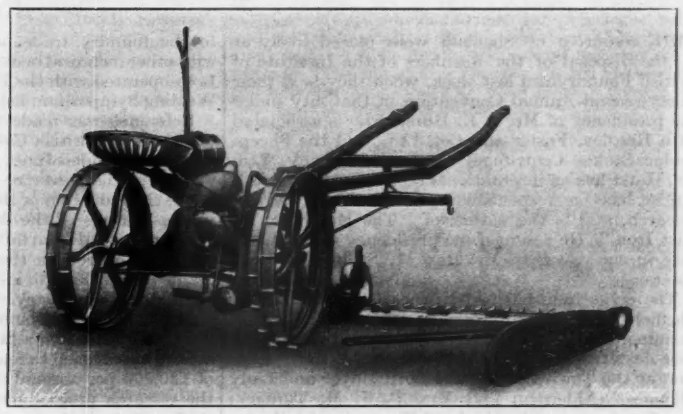


FIG. 17—GRASS MOWER—BAMLETT

It is made in two sizes of 2 and $2\frac{1}{2}$ tons respectively. The total width rolled is 4ft. $0\frac{1}{2}$in., and there is an overlap of rolls on each side of $3\frac{1}{2}$in. The wheel base is 6ft. 2in. and the overall length 9ft. 10in. The fuel tank has a capacity of 5 gallons, and when water sprays are required a tank of 15 gallons capacity is provided for water, giving a gravity feed to the sprays. The power unit is a four-cylinder petrol engine, giving 12·8 b.h.p. at 1000 r.p.m. Two speeds are arranged, giving 1·8 and 3·7 m.p.h. respectively, and the transmission is by spur and bevel gears, providing smooth and silent operation.

J. AND H. MCLAREN.

At Newcastle, Messrs. McLaren showed, amongst other types of plant, a set of ploughing windlasses operated by oil engines, developing 60–70 b.h.p. when running at a speed of 800 r.p.m. The engines are started by a two-cylinder, water-cooled petrol engine. Each winding drum is fitted with coiling gear and 450 yards of wire rope. Three winding drum and road speeds are obtainable. For operating with this windlass system a six-furrow anti-balance plough, with a patented regulator gear, which enables reversing to be done by one man, is fitted. There was also on view a five-cylinder oil engine, 84 b.h.p. at 1000 r.p.m., which is mounted on an extended built-up bed-plate and direct-coupled to a 50 kW D.C. generator.

SOME NEW IMPLEMENTS.

The judges in the new implements section awarded only one silver medal at Newcastle, and that was for the transportable hay rake, shown by Blackstone and Co., Ltd., Stamford. The rake is designed to be hauled by a tractor, and it is equipped with a simple pawl mechanism by which the tines can be raised or lowered by the man on the tractor without dismounting. Of the appliances in this competition which did not obtain any reward, the Fishleigh rotary cultivator shown on the stand of the B.H. Brown Engineering Company, Ltd., Newcastle-upon-Tyne, has much to commend in its principle of operation for cleansing pastures and for clearing weeds from arable land before sowing the seeds. This 6ft. cultivator is designed for tractor haulage, and the steel rotor is driven through a gear-box at a speed of 170 r.p.m. It carries a number of carbon steel tines arranged in staggered formation so as to

thoroughly disintegrate and clear the ground by a helical action. Although it is not a plough, the Fishleigh cultivator can carry out in one operation the functions performed by individual cultivating and harrowing machines. The machine is made by the Fishleigh Cultivator Company, Bideford, Devon.

Another very useful appliance which was seen for the first time at the Royal Show at Newcastle is a power-operated bracken cutter, called the "Collins," which is built by W. Henderson and Sons, Mauchline, Ayrshire. This handy machine is operated by a 350 c.c. J.A.P. petrol engine, which propels the machine through a three-speed gear-box and hand-controlled clutch, and also drives, by means of a belt, a vertical rotary cutter carried in front of the machine. A cut 6ft. in width is taken at speeds from 1 to 6 miles per hour. A special feature of the two cutter blades is that they are each hinged in two places so that they yield if they strike solid bodies and thus prevent damage. The necessity for this hinged arrangement will be gathered from the peripheral speed of the cutters, which is over 5000ft. per minute.

Another new farm implement which the judges did not look upon favourably enough to award it a silver medal is a grass mower made by A. C. Bamlett, Ltd., Thirsk. In this machine (Fig. 17) the cutter knife is operated by a 2½ h.p. air-cooled petrol motor mounted on the frame, but the machine is hauled by animal power, one horse being sufficient for the purpose instead of two as is usual. By this arrangement the cutting speed of the knife is made independent of the rate of progress of the animal.

Still another machine which we had not seen prior to the Show is called the "Overgreen" motor mower made by Ransomes, Sims and Jefferies, Ltd., Ipswich. In this machine the power is supplied by a 3½ h.p., four-stroke, petrol engine through transmission gear to two pneumatic-tired wheels. The motor unit draws three special roller mowers, which are universally connected so as to allow them to float smoothly and independently over undulating golf greens like a gang outfit. The cutting is performed in concentric circles. For transport purposes the cutting units are lifted clear of the ground and are carried on pairs of light rubber-tired wheels, the change being made in a very brief time.

The protection of the Show yard against fire was entrusted, as in former years, to Merryweather and Sons, Ltd., who had their usual display of fire-fighting appliances, including a Greenwich Salamander fire-engine, the motive power for which is supplied by a four-cylinder petrol engine fitted with a Hatfield reciprocating pump. Other exhibits by this firm included trailer pumps of the reciprocating pattern, and chemical "extinctors."

The Institute of British Foundrymen.

No. I.

THE resources of Sheffield were placed freely at the disposal of the members of the Institute of British Foundrymen last week, when they held their thirty-second Annual Convention in that city under the presidency of Mr. J. E. Hurst, who is associated with Bradley, Foster and Co., Ltd., and the Sheepbridge Stokes Centrifugal Castings Company, Ltd. Mr. Hurst has an international reputation as a metallurgist, has been responsible for a great deal of original research, and is the author of "The Metallurgy of Cast Iron." He assumed the presidency of the Institute in succession to Mr. Roy W. Stubbs, of Manchester.

The civic, industrial, and educational interests of Sheffield combined to provide a very attractive programme of instruction and entertainment during the four days from July 2nd to July 5th. A civic reception at the Town Hall by the Lord Mayor and Lady Mayoress (Alderman and Mrs. P. J. M. Turner); an official welcome by the Lord Mayor, by the Master Cutler (Mr. Alex Williamson); and by the President of the Sheffield Chamber of Commerce (Mr. A. K. Wilson); the annual banquet and dance, at which the Institute had the opportunity to entertain its many friends in Sheffield; a reception by the Vice-Chancellor of the University (Dr. A. W. Pickard-Cambridge) and Mrs. Pickard-Cambridge; a luncheon at the invitation of the Sheffield Branch of the Institute; a drive into Derbyshire and a garden party by invitation of the President and Mrs. Hurst were all included in the social activities.

In addition to the technical meetings, the members devoted two afternoons to visiting various works, which included those of Steel, Peech and Tozer, Ltd., Hadfields, Ltd., the Sheepbridge Stokes Centrifugal Castings Company, Ltd., the foundry department of the University, the English Steel Corporation, Ltd., Newton, Chambers and Co., Ltd., General Refractories, Ltd., and the United Steel Companies' research laboratories, and the high-frequency induction furnaces of Samuel Fox and Co., Ltd.

A special programme of visits was arranged for ladies attending the Conference.

The Council's Annual Report.

All the meetings were held in the Mappin Hall of the University.

The annual report of the Council for the year ended April, 1935, was unanimously adopted. It reflected considerable activity in all branches of the Institute's work, and gave rise to general satisfaction.

Although 181 new members were added during the year, the names of 233 were removed from the roll—a net loss of 52. The reduction was due partly to trade conditions, which are usually reflected in the membership of the Institute a few years afterwards, but the principal cause of the reduction was the drastic revision of the register, the result of which is that the great majority of the present membership of 1780 are the really active members. This was borne out by the financial statement, which showed that in spite of reduction of membership, there was practically no reduction of income from subscriptions.

It was reported that Sir William J. Larke, director of the British Iron and Steel Federation, and Mr. S. G. Smith had been elected honorary members, in recognition of their services to the industry and to the Institute in particular.

The Institute has maintained and strengthened its relations with other technical organisations. It is now represented, through its Technical Committee, on most of the important B.S.I. Committees of interest to the foundry trade, and maintains close contact with other technical bodies in the engineering industry. It co-operated with the Iron and Steel Institute in the Welding Symposium, held recently in London.

Reference was made to the fact that the annual report of the British Cast Iron Research Association for the year ended June, 1934, showed that the income was the highest ever recorded in the history of that body, the reduction of the Government grant in 1932, in consequence of the depression, having been more than made good from industrial sources. The Government had offered for the current year to increase the grant by £2000 provided an additional £1000 was secured from industry. The Government offer also provided for further increase in grant as the industrial income increased, in a manner which made it possible for the Association to reach before 1940 a total income of £20,000 per annum. In line with this expansion, the research programme had been enlarged and the staff increased.

A Degree Course in Founding at the University of Sheffield was established in the autumn of 1934, and is now in operation. The Institute was responsible for much of the preliminary work in connection with the establishment of the course, and a number of firms have pledged financial support for seven years.

Progress has been made in connection with the establishment of the intensive course in foundry practice designed for persons already engaged in the foundry industry, which is to be established at the Birmingham Central Technical College under the auspices of the British Cast Iron Research Association.

The Technical Committee.

The third annual general report of the Institute's Technical Committee was presented and adopted. This Committee is concerned with the investigation and correlation of technical information and has sub-committees whose work covers almost every branch of foundry practice. For example, a sub-committee on costing has prepared an interim report on melting costs; that report was presented to six branches during the winter and the suggestions made at the meetings are being utilised by the Committee. This practice is followed in connection with other reports.

A report on tolerances of dimensions of malleable castings has been prepared by the Malleable Iron Sub-Committee, and it is being extended in consultation with other sub-committees, so that it will be eventually a comprehensive report on the subject, dealing with all types of castings.

In addition to the sub-committees on costing and on malleable cast iron, there are others dealing with melting furnaces, sands and refractories, cast iron, non-ferrous castings and steel castings.

Another important function of the Technical Committee as a whole is that it has become the recognised medium for keeping in contact with other organisations, such as the B.S.I. It is also investigating a suitable test for relative fluidity or "castability" of metals, and individual members of the Committee are carrying out exhaustive tests on apparatus; efforts are being made to standardise nomenclature; an exhibit is being arranged for the Foundry Exhibition in association with the Shipping, Engineering and Machinery Exhibition at Olympia in September; and the Committee has had in operation for some time an inquiry bureau for the benefit of members of the Institute.

Vice-Presidents.

The Senior Vice-President elected for the year 1935–36 was Mr. H. Winterton (Scottish Branch), and the Junior Vice-President Mr. C. W. Bigg (East Midlands Branch).

Presidential Address.

Mr. Hurst's presidential address was devoted to the subject of the heat treatment of cast iron. He adopted as his text a sentence from an address delivered by Professor T. Turner at the Birmingham conference of the British Foundrymen's Association (the forerunner of the Institute) in 1909, under the title "Twenty-five Years of Cast Iron," wherein it was stated that the renewed and extended interest in cast iron came as a surprise to those who believed the days of the ironfounder to be numbered, and was a revival as unexpected as it was pronounced.

The remarkable developments in the metallurgy of cast iron during recent years, said Mr. Hurst, had been accompanied again by a revival of interest exactly as twenty-five years ago. He felt that the importance of the heat treatment of cast iron was only just beginning to be realised, and was of opinion that with further research and progress the facility to heat-treat would play a vital part in maintaining and extending the industrial development of cast iron. Whereas in the past leading metallurgists had stated categorically that by exposure to high temperatures cast iron was ruined, the position had since been changed completely, and metallurgists were able to show equally emphatically that by exposure to high temperatures, as in correct heat treatment, the properties of cast iron were considerably improved. A substantial tonnage of iron castings was being heat-treated commercially and accepted by engineers without any qualms or misgivings as to inferiority in mechanical properties.

This change of view, in so far as hardening and tempering cast iron was concerned, had been brought about in large measure by the pioneer investigations of firms in the Sheffield district. He dealt with this matter briefly, and said that the discovery of the rational response of cast iron to hardening and tempering treatment had led to the study of the influence of alloy additions in respect to this treatment. The effect of alloy additions on the capacity of cast irons for heat treatment had already been of major importance in the economic justification of these additions to cast iron, as in the case of steels. As an example he referred to some experimental work in connection with a rather complex alloy cast iron containing aluminium, chromium, and nickel; after exposure to temperature conditions in the neighbourhood of 500 deg. Cent. there was a marked falling-off in tensile strength and resilience value. On the assumption of an apparent analogy between these phenomena and those of temper brittleness in steels, the effect of additions of molybdenum were investigated; experiments had shown clearly that molybdenum, either alone or in conjunction with aluminium, did not reduce the strength after low-temperature treatment at 500 deg. Cent. under nitrogen hardening conditions, and that it was also effective in preventing the reduction of strength under those conditions when nickel was present in the alloy. Mr. Hurst gave results to illustrate that, and said it was possible, of course, that that aspect of the influence of molybdenum was of importance in other considerations of this element in cast iron.

Another factor discussed was that, as shown by recent experimental work, the results obtained by heat treatment of cast iron were influenced to an extraordinary extent by the form in which the graphite existed. For example, the hardening and tempering of cast irons having the ferrite/fine graphite structure had been accompanied by increases in strength of well over 100 per cent. in comparison with the untreated condition. He gave experimental details showing the effect of the amount and form in which the graphite existed.

Experimental work had shown also that all varieties of malleable cast iron responded to hardening and tempering treatments; it was possible to bring about a variety of changes by suitable heat treatment. One important deduction from experimental results, for example, was that with a suitable heat treatment by hardening and tempering, the properties of blackheart malleable could be made to resemble closely those of good whiteheart malleable. This served to emphasise that heat treatments of this type were available for use in obtaining modifications in the mechanical strength properties, and that their value did not lie only in their ability to produce hardened surfaces. That applied with equal force in the application of such heat treatments to grey cast irons and he ventured to predict, would assume far greater importance in the future metallurgy of cast iron.

Nitrogen hardening was quite a different form of heat treatment, belonging essentially to the category of case hardening processes. The process was first extended to cast iron and a suitable alloy cast iron now known as Nitricastiron, was developed by the firm with which he was associated. It was an aluminium-chromium alloy cast iron, and by treatment in ammonia gas was capable of yielding surfaces of 1000 Firth diamond hardness and over. That was a development as unexpected as it was pronounced, and had proved to be of great commercial importance. Its extension to other alloy cast irons was being actively pursued, and particularly in the case of austenitic cast irons it promised to be of equally great import-

ance. Temper hardening effects in certain alloy cast irons, particularly the austenitic cast irons, were also the subject of brief reference, and Mr. Hurst gave details of the treatment of a nickel-manganese austenitic cast iron which was clearly susceptible to temper hardening.

It was to be hoped, he concluded, that the developments in foundry education would direct the attention of students to that section of metallurgy and enable them to participate in its future progress.

MAN AND METAL.

To commemorate the presidency of Mr. C. Edward Williams, of Cardiff, in the year 1933–34, the Institute has founded an annual lecture, to be delivered each year by a prominent man in industry or science.

Sir William Larke delivered the first "Edward Williams" Lecture and chose as his title "Man and Metal." In it he surveyed briefly the development of the use of metals and their influence upon man's progress. When we considered our dependence on metals to-day, he said, their paramount influence on the development of mankind and our intellectual and material civilisation, it was remarkable that, although it was generally accepted that man first appeared on the earth 300,000 years ago, there was no conclusive evidence that he had any knowledge of metals earlier than 4000–5000 years before the Christian era—say, the last 7000 years. It was only in the last 200 years that metals had rendered possible that revolution which had converted handicraft into industry.

During the present century more metals had been produced than during the whole period of historic time preceding 1900.

Copper was the first metal known in the ancient world, at least in Egypt and the East. The working of copper appeared to have reached a relatively high standard in very early times, and copper smelting was probably discovered about 4500 B.C., no doubt accidentally, probably following a camp fire which had been built in a circle of stones containing ore, when beads of copper were observed on the stones after the fire was extinguished and were recognised as being the same as the native metal.

Probably the discovery of gold preceded that of copper, but gold was used for decorative purposes about 3500 B.C.

The development of smelting brought more metals to the notice of man. Bronze appeared about a thousand years later than copper and represented a considerable advance, with its lower melting point and greater beauty and hardness. Lead, produced before 3400 B.C., in sheet form, was used as a damp-course in the walls of Babylon. It was not used to any great extent, however, until the sixth century B.C., when it was used for water tanks. Brass, probably also an accidental alloy, was known in Palestine as something distinct from copper about 1500 B.C. Mercury was imported into Egypt between the fifteenth and sixteenth centuries B.C., presumably from Spain.

It was the discovery of iron, however, which had given the greatest impetus to the development of man, both intellectually and materially. There seemed no doubt that the earliest iron worked by man was of meteoric origin. The date and place of the origin of iron smelting could not be definitely determined. There was evidence that iron was used in Babylon about 2500 B.C., and became comparatively common in 1400 B.C., in the form of steel showing carburisation. The smelting of iron as a craft appeared to have originated on the shores of the Black Sea, where there was available a particularly pure magnetic iron sand. The Taurus Mountains and the foot of the Caucasus were also suggested, as the local ore contained manganese and a good-quality iron was produced.

The Iron Age did not appear to have commenced in Britain until about 400 B.C. and Ault had suggested that from the general introduction of iron tools and weapons might be dated the development of man from a hunter into a farmer. As the result of storing food supplies, domesticating animals, and through the exchange of food for tools and weapons, he had become a trader and a capitalist. It was significant that iron was used as currency in the shape of bars in this country, a practice probably introduced from the East.

For the next 2000 years, whilst the use of metals became more common, their application did not change in character. The principal advance was the introduction of cast iron about 1340 A.D. Cast iron was not converted into malleable iron until the invention by Cort of the puddling furnace 440 years later. As production was simplified and the use of metal tools for agriculture and handicrafts generally, as well as for weapons of war, became more widespread, they became available to a much greater number and thus unquestionably raised the standard of life of the people as a whole. No doubt this development also tended to create classes of society, since metal tools and weapons were a form of wealth which could be accumulated.

In this country there had been during the historic period, say, from the date of the Norman Conquest, three main phases of industrial development. The first and longest was a continued development of metal handicraft, and it had lasted until the early part of the eighteenth century. The second was the age of coal and iron; and the third, commencing with the present century, was the age of alloys and electricity.

Sir William traced the development during the last century or so, which had been made possible by the extended production and application of metals, and their influence on railways, motor cars, aircraft, and machinery generally, and on electricity and telegraphy. In this country the electricity grid already comprised 4000 miles of transmission line and was the result largely of the development in the last twenty years of the production of aluminium, the most efficient electrical conductor per unit of weight, which was discovered only in 1825. It had become one of the most important metals, and seemed destined to fill even a more important *rôle* in the future. In the electrical grid in this country 12,000 tons of aluminium had been used for transmission lines and the supporting towers had required 150,000 tons of steel.

Although the present appeared to be dominantly a steel age, cast iron was still one of the most important structural materials. We were apt to forget what an important structural material it had become. The tube railways of London were built of cast iron sections, of which approximately 1,000,000 tons was already erected. The Mersey Tunnel contained no less than 80,000 tons of cast iron, and the road was paved with cast iron blocks having non-skid, glass-hard surfaces. All metals used to-day were first cast before they were otherwise treated or manipulated, and it was at the casting stage that the metals or alloys received their basic characteristics, on which depended their ultimate qualities. It was for this reason that there were no less than four important research organisations dealing with casting—the British Cast Iron Research Association, the Steel Castings Committee, the Heterogeneity of Ingots Committee, and the Non-Ferrous Metals Research Association.

Sir William recalled the discovery of manganese and silicon steel by Sir Robert Hadfield in the early 'eighties of last century, and said that modern electric transmission and the large generating units now used would have been impossible without the discovery of the properties of silicon steel for use in electrical transformers and machines. One of the most important metallurgical developments of the last twenty years was the production of chromium steels, the properties of which were discovered in the Brown-Firth Laboratories at Sheffield by Mr. Harry Brearley in 1913. He also referred to the development of tool steels and the hard alloys of non-ferrous metals, and said that the extension of power which these products had given to the engineer were almost incalculable.

Discussing the contribution of metallurgy to aviation, he said that the authorities he had consulted considered it probable that aircraft engines for ordinary service in the near future would be reduced to a weight of about 1 lb. per b.h.p.

Of recent engineering triumphs based on steel, he mentioned the Sydney Bridge, having a span of 1650ft., the arch of which contains 38,000 tons of special high-tensile steel, which alone might be said to have rendered the design practicable; the Iraq oil pipe line, 1200 miles long, welded throughout; and the "Queen Mary," which, when launched, was claimed to be the largest mass—40,000 tons—ever moved by man unaided by mechanical power.

He also discussed the development of the duralumin series of alloys, invented in the present century, and the increasing use of the rarer metals. The application of these rare metals had enabled the efficiency of electric incandescent lamps to be increased from 3·1 to 11·5 lumens per watt within the last thirty years. Broadcasting also was ultimately dependent on the work of the metallurgist.

This summary, he said, showed that metallurgical progress in the present century had been almost as great as in the whole previous history of mankind. He exhibited a table, specially prepared by the Mineral Resources Department of the Imperial Institute, in which the world production of the various important metals since 1900 was given. From 1900 to 1929, the peak year, the world production of steel was multiplied more than four times, of copper approximately four times, and of aluminium thirty-five times. The rate of increase in the production of the rarer metals was no less impressive and significant, although their quantities were smaller.

His survey served not only to demonstrate the important part which metallurgists had played in the development of our civilisation, but also to indicate the potentialities of the future and the consequent responsibilities resting on the metallurgical industries for continued research to meet the demands of engineering for new and improved materials. A new industrial revolution, almost unnoticed, was in progress, pregnant with far-reaching results for the future. It was based on the almost daily discovery of new materials, having new properties capable of standing increased stresses under varying conditions of static or dynamic load within wide ranges of temperature.

Sir William Larke exhibited a film illustrating ancient and modern methods of the production of iron. The ancient method was that still used by some tribes in India, the natives using a furnace having a small superstructure of puddled clay, with elementary tuyeres, and using goat-skin bellows, the latter being worked by the feet. The iron produced, which was extraordinarily pure, was in the form of a spongey mass.

(To be continued.)

American Engineering News.

Ammonia-chlorine Water Treatment.

THE Waterworks Department at Chicago will put into operation in July what is thought to be the largest ammonia-chlorine plant ever built for the treatment of domestic water supply. It is situated on one of the intakes in Lake Michigan, two miles from shore. The structure is 100ft. in diameter and is built around the top of a shaft carrying the water down to a tunnel which extends to distribution pumping stations at some distance inland. The average flow is such that water passing into the shaft reaches the pumping stations in about seven hours, so that chemical application at the intake gives a desirably long period of contact with the water. With the ammonia-chlorine treatment a contact period of about two hours is necessary for efficient results. Such a period could not be obtained if the application of chemicals was made at the pumping stations. Since ice conditions sometimes cut off communication with the intake structure for as much as three or four weeks in severe winters, a storage of supplies sufficient for forty days is provided. Ammonium sulphate packed in 100-lb. sacks lined with paper is found to be the most suitable material as to economy and also as to safety and ease in handling. Chlorine is stored in containers of 1-ton capacity. For transporting the chemicals, oil, and liquid ammonia—if required by price conditions—there is a welded steel barge, 100ft. by 30ft., having its deck fitted to carry thirty of the 1-ton chlorine drums and forty containers, each holding twenty of the 100-lb sacks of ammonium sulphate. Three measuring and controlling devices with a capacity of 3500 lb. of chlorine daily are provided to chlorinate the flow of water into the intake shaft, with two dry chemical feeders to apply from 20 lb. to 200 lb. per hour of the ammonium sulphate. This chemical is fed near the top of the shaft and is thus well mixed with the water before it receives the chlorine at the bottom of the shaft.

American Machinery Requirements.

A recent study of conditions in American manufacture indicates that the need for actual replacement of machinery amounts to the enormous total of £3,715,000,000 in the machinery industries alone. This is exclusive of the needs for equipment in other industries, such as housing and other constructional needs, which are estimated at some £2,200,000,000. The requirements for the machinery and allied products industries are classified as follows:—

Foundry and machine shop products, £1,460,000,000, or 40 per cent. of the total.

Electrical machinery and apparatus, £1,212,200,000, or 33 per cent. of the total.

Engines, turbines, tractors, and water wheels, £240,700,000, or 7 per cent. of the total.

Agricultural implements and machinery, £146,300,000, or 4 per cent. of the total.

Machine tools, £145,000,000, or 4 per cent. of the total.

All other machinery, £510,800,000, or 12 per cent. of the total.

Machinery needed by the manufacturers of machinery represents £9,075,000 divided nearly equally between replacements and additions. Allowing 65 per cent. of the grand total—£3,715,000,000—for the pay roll or labour charge, this would amount to £2,401,460,000. Present conditions favourable for the purchase of machinery are listed as follows:—Prices are at a minimum; firms with funds drawing little or no interest might well invest them in their own works; skilled mechanics are more plentiful now than they will be later, owing to unemployed mechanics drifting into other occupations; men now on the pay roll can be kept busy; machinery can now be delivered promptly and installed with less trouble than when the works are busy; the urgent necessity of reducing production costs must be met by adequate and efficient plant equipment.

Chemical Treatment of Sewage.

While chemical treatment of sewage was introduced by American engineers several years ago, the method was soon dropped, mainly on account of the high cost of chemicals and the rapid development of less expensive biological methods of treatment. In the past few years, however, there has been a marked revival of chemical processes, taking a place between simple sedimentation—which is only partially effective—and the highly efficient but costly activated sludge and sprinkling filter processes. At present more than fifty cities in the United States are using chemical precipitation, either alone or in combination with biological processes, while a score of such plants is proposed for early construction. In most cities, the sewage reaching the treatment plants for six to eight hours daily requires only sedimentation to produce a satisfactorily stable effluent. With that treatment a degree of purification of 35 to 40 per cent. is attainable. By supplementary chlorination to reduce further the oxygen demand, the purification may be raised to 55, 60, or even 65 per cent. This again may be raised to 65 or 70 per cent. by combining coagulation with the sedimentation; or as high as 80 to 85 per cent. by a combination of chemical precipitation and chlorination. The older coagulants of ferrous-sulphate and lime, which require aeration for effective results, are now supplemented by ferric chloride, anhydrous ferric sulphate, and chlorinated ferrous sulphate, which last is known as chlorinated copperas, and is the most economical. The increased quantity of sludge from chemical precipitation is in some cases an objection, but modern methods of sludge disposal include dewatering on vacuum filters and incineration. At Dearborn, a multiple-hearth incinerator is used, having oil burners in three of the six super-imposed hearths, which are 18½ft. in diameter.

Controlled Concrete.

IN all materials used by the engineer a precise definition of their properties as to strength and behaviour is an essential. To attain this object, laboratories and testing machines are to be found in every works, giving to the manufacturer accurate figures on every quality possessed by the material. In handling the product, too, exact methods are used to ensure that none of its qualities are jeopardised, so that the finished product can be guaranteed for strength under various conditions of working.

Concrete, a material like any other available to the engineer, can be treated in the same way. Comprehensive and exact data are available as to its performance under load and the various methods of increasing one or other of its qualities are known. In view of the enormous and growing use of concrete in modern civil and structural engineering, it is not surprising that this mass of knowlege has been collected. What is surprising is the way in which it is sometimes handled, despite this scientific knowledge. To manufacture any material under the conditions to be met with on the site of building operations deprives the manufacturer of all the assistance which would be available in a works equipped for the purpose, properly sheltered from the elements, and handling a steady output of the material. Raw materials are exposed to the elements and are proportioned by crude methods, and the mixing has to be carried out in small quantities, often without adequate supervision. The strength of concrete is well known to depend directly on the water-cement ratio, but sand, the degree of dryness of which is quite unknown, is added to the mixture and may have a water content sufficient to alter the entire mixture. Furthermore, the aggregates may become mixed together or with local rubble, owing to rough-and-ready storage methods. Finally, the whole process is often hurried or delayed to meet the needs of the laying gang, whose proximity and needs exert an undesirable influence on the process of mixing.

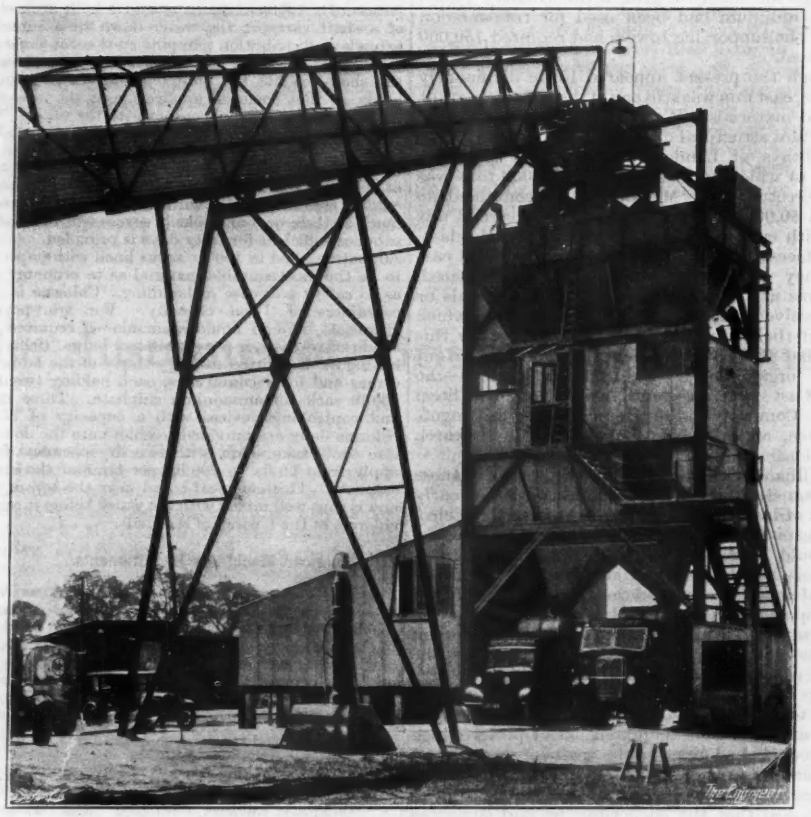


FIG. 1—CONCRETE BATCHING PLANT

The necessity for providing concrete produced to meet the requirements of scientific accuracy in order that its properties might be guaranteed has led to the construction of a "concrete factory" by Scientific Control Concrete, Ltd. The works at Thorpe, near Egham, Surrey, were opened on February 21st last by Mr. W. P. Robinson, engineer for the County of Surrey. The actual concrete batching plant will be seen in Fig. 1. A conveyor carries the material to the filling floor, where a distributing hopper travelling across the roof drops the material into one of four hoppers. These are to be seen above the weighing room, and reading from right to left contain sand, and three different aggregates. This material is purchased in a screened condition and dumped at the foot of the conveyor until required. In addition, cement is fed into an independent insulated hopper from a totally enclosed conveyor on the opposite side of the works, which is filled from a special store house. The interior of the weighing room is to be seen in Figs. 2 and 3. Fig. 2 shows the levers operating the doors of the four hoppers containing the sand and aggregates. Behind these levers the weigh beams, shown in Fig. 3, are just visible. The weighman thus controls the descent of each of the materials required for use, and releases each after the weighing operation is over. As will be seen in Fig. 1, two outlets are provided for the weighed quantities. The four weighing hoppers, which are situated one under each of the upper hoppers, discharge together through a leather chute into one of these outlets into the lorry beneath. The cement is discharged at the same time from its own hopper. Thus all the dry materials enter the lorry together, and a certain amount of preliminary mixing takes place *en route*. The water supply is weighed in a tank on its own weighing machine, to be seen in Fig. 2, and is discharged into the water tank of the lorry.

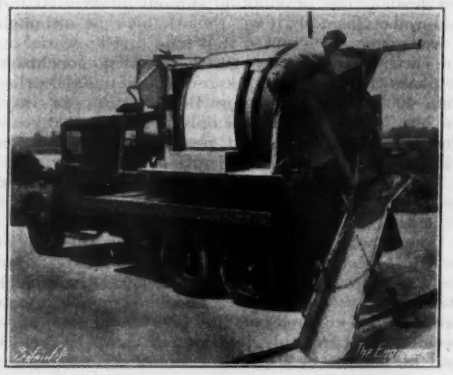


FIG. 4—DISTRIBUTING LORRY

It will be seen that the batching of weighed materials is carried out with the minimum of wasted labour and time. The system used for weighing is that of Jaeger Truck Mixers (England), Ltd., of 54, Victoria-street, S.W.1, which is responsible for the plant and for the methods used in the production of the concrete. This process starts with a test of each batch of sand or aggregate to ascertain the dryness fraction, through the specific gravity. The small weighing machines visible in Figs. 2 and 5 are used to obtain this figure, and this test, only taking a few seconds, provides a solution to the problem of the water content in the sand or aggregate. Having obtained the dryness fraction for the materials, the weighman adjusts the sliders on the large weighing machines in Fig. 3 to the necessary corrected value, thus obtaining a true reading for the weight of dry material. At the bottom of the beam cupboard will be seen some of these correction weights. Each material is weighed against the sand. Thus, first, the sand is weighed on beam 1, then the first aggregate on beam 2 is weighed against the sand, and so on. A certain amount of water has been allowed to enter the lorry in the materials. This is allowed for when weighing the water, the correction being the sum of the water contents of each material. The cement is weighed separately on the No. 4 beam in Fig. 3.

In Fig. 5 a corner of the laboratory is shown. Here

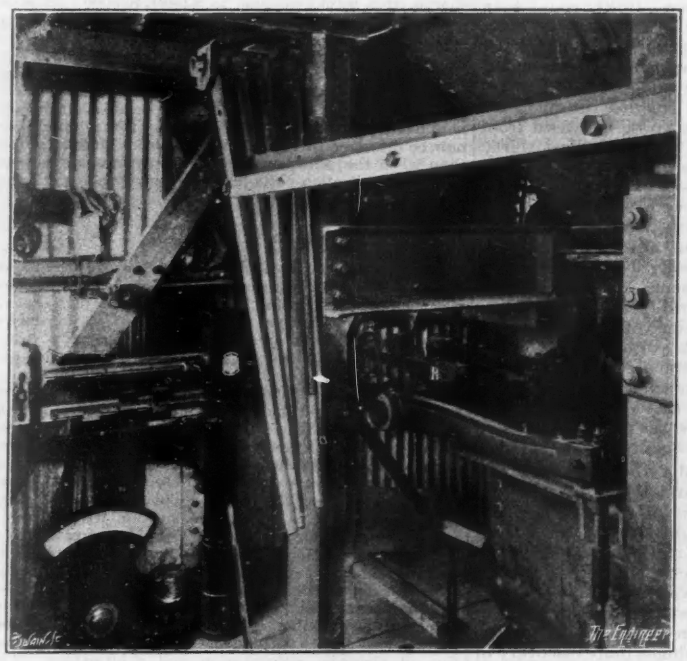


FIG 2—INTERIOR OF WEIGHING ROOM

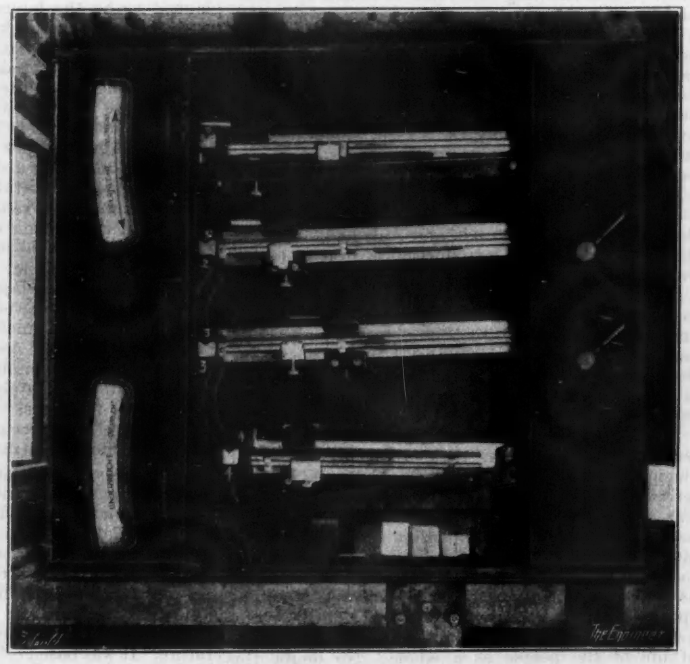


FIG. 3—MULTIPLE WEIGHING MACHINE

continuous tests are carried out, both to ensure the accuracy of the concrete passing out of the works and to obtain data with regard to the raw materials. A moulding press is shown in use, while on the bench is seen the test mould made by Jaeger Truck Mixers, Ltd., for "the Slump test." This test provides a measure of consistency of the concrete, the number of inches of "settlement" which occurs being used.

Having been carefully proportioned by their dry weights at the works, the materials are loaded into the distributing lorry, which carries in a separate tank the correct measured quantity of water. This lorry may be seen in Fig. 4. The equipment which can be mounted on any suitable chassis is built by Ransomes and Rapier to the order of Jaeger Truck Mixers (England), Ltd. It consists of a small petrol engine situated between the driver's cab and the mixing drum, which rotates the drum through a reverse gear-box and a clutch. The driver is shown opening the discharge door, with his left foot on the accelerator of the engine. Dual controls are provided at both ends of the running board. The material is loaded through an opening in the top of the drum and delivered at the discharge door on to a scoop which is shown in the lowered position for discharging on to a road surface, while the lorry travels slowly forward. In the travelling position the scoop is secured to the bracket beside the driver's

FIG. 5—A CORNER OF THE LABORATORY

left hand. By this arrangement the delivery of the concrete takes place rapidly and on the site it is distributed evenly over the area where it is required. The drum is rotated backwards to discharge, thus driving out the concrete on the principle of the Archimedean screw, as will be understood by reference to Fig. 6, which shows the interior arrangement of the drum. The water enters the drum from the tank on the left through one of the trunnions and passes *viâ* the central pipe to the screened distributing sprayer, being controlled as to quantity by the valve, the graduated lever of which is visible on the end of the tank.

The journey to the site where the concrete is to be laid is accomplished with the water turned off, the drum stationary, and the material inside in a dry condition. Only when within five to ten minutes' drive of the site does the driver start up the mixer engine and turn on the water. The mixture thus arrives in a freshly mixed condition.

A separate compartment in the water tank contains

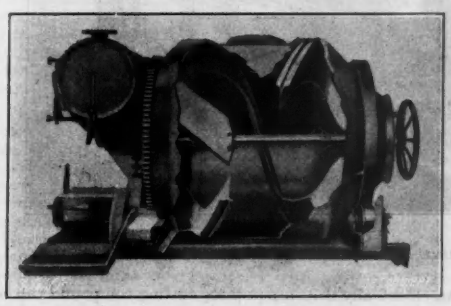


FIG. 6—ARRANGEMENT OF DRUM

"wash water," with which the drum is filled after the concrete has been emptied out, for washing purposes.

An advantage claimed for this system from the economic point of view is that the concrete is of such a uniformity of texture that substantial savings are made in the costs of "surfacing" and "making up" cement, even occasionally superseding them altogether. The speed of working becomes that of the gang "laying" the concrete as by the use of several lorries uninterrupted placing of the concrete takes place. In the event of rain or other interruption of the work occurring no material is wasted, as the driver does not start mixing unless sure that laying will take place, and the lorry contents are therefore still in a dry condition. At the new reservoir under construction on Ascot racecourse, there was an occurrence of this kind, when sudden rainfall caused a flood which held up work for several hours. During the time four lorries arrived containing a total of 8 cubic yards of unmixed concrete. The drivers on the approach of rain did not mix their loads, and thus no wastage occurred.

We understand that already two County Councils are specifying this concrete, while the system has grown enormously in Canada and in the United States of America.

High-Speed Test Run of L. M. S. Locomotive.

THE London, Midland and Scottish Railway gives the following official details of the high-speed run by the standard 4–6–2 locomotive No. 6200, "The Princess Royal," designed by Mr. W. A. Stanier, on a test run with the 5.25 p.m. Liverpool (Lime-street) to London (Euston) express, on Thursday, June 27th.

This train, which has the fastest start-to-stop booking on the L.M.S. system, viz., 142 minutes for the 152·7 miles, Crewe to Willesden Junction (average speed 64·5 m.p.h.), has a normal load of from 300 to 360 tons, but on the occasion in question the load was made up specially to fifteen vehicles, including dynamometer car—453 tons tare or 475 tons with passengers and equipment—in order that the capacity of the engine for hauling heavy loads at continuous high speeds might be adequately investigated.

The test proved eminently successful, the arrival at Euston being fourteen minutes early on the overall schedule of 3 h. 20 min. for the 193·7 miles from Liverpool to Euston, including two stops (Crewe and Willesden) of a total duration of five minutes.

From Crewe to Willesden the distance of 152·7 miles was covered in 129 min. 33 sec., start to stop, representing a gain of 12 min. 27 sec. on the scheduled allowance for this section, and an actual average speed of 70·7 m.p.h. These are claimed to be exceptional figures in this country for a locomotive hauling so heavy a load on so long a journey, especially since the engine had worked from Euston to Liverpool earlier in the day and had been given no special preparation.

Features of the Crewe-Willesden run were averages of 73·3 m.p.h. over the 139·5 miles Whitmore to Wembley, and 77·2 m.p.h. over the 67·2 miles Welton to Wembley, while maximum speeds of 80 m.p.h. or over were attained at eight well-separated points on the journey. The highest speed actually touched was 86·6 m.p.h. for half a mile between Hemel Hempsted and King's Langley stations, while a speed of 85·4 m.p.h. was attained both at Hademore (between Lichfield and Tamworth) and on the descent of the Buckby Bank before Weedon Station.

The uphill work was also of an exceptional character. The 10·5 miles of continuous adverse gradients from the Crewe start to passing Whitmore were run in 12 min. 33 sec., the minimum speed on the 1 in 177 rising gradient between Betley-road and Madeley stations being 57·7 m.p.h. Other notable speeds at the conclusion of uphill stretches included 73·5 m.p.h. at Shilton Summit (Mile Post 92), 67·2 m.p.h. on leaving the Kilsby Tunnel, 71·5 m.p.h. at Roade Summit (M.P. 60), and 67·2 m.p.h. at Tring Summit. It will be noted that the 15 miles of largely adverse gradients from Bletchley to Tring were run, with this heavy load, in 12 min. 33 sec.

During the first hour from starting from Crewe the train covered a distance of 66·7 miles, and in the second hour 74·1 miles.

The overall time of 129¼ min. from Crewe to Willesden includes the observance of severe speed restrictions at Stafford and over the Polesworth Colliery subsidence, through Rugby station and yard, and in a lesser degree at Norton Bridge. Speed was also slightly moderated over the curves through Weedon Station and between Weedon and Heyford.

Driver H. P. Smith and fireman T. B. Pile, of the Camden Motive Power Depôt, were in charge of the engine, accompanied by Inspector S. E. Miller, of Willesden. Also on the footplate was Mr. R. A. Riddles, Principal Assistant to the Chief Mechanical Engineer, while in the dynamometer car were Mr. S. H. Fisher, Assistant Chief Operating Manager, and Mr. F. A. Pope, General Assistant to the Chief Operating Manager; the timing of the run—details of which are given hereafter—was performed to the requirements of these officers by Mr. D. S. Barrie. The maximum and minimum speeds quoted were recorded by a continuous split-second chronograph over minimum distances of half a mile and checked against the dynamometer recorder.

During the run the engine was driven in the normal manner for this type, with the regulator fully opened and on as early as cut-off as possible consistent with the work required. A maximum cut-off of 30 per cent. was used on the ascent from Crewe to Whitmore, 15–18 per cent. being otherwise generally employed, with the exception of 25 per cent. on the ascent to Tring Summit. The engine steamed satisfactorily throughout and was found to be in excellent condition on arrival at Euston. The run was achieved without exceptional preparation, while the enginemen were those who would normally have worked the train in any case. An absolutely clear road was obtained throughout, notwithstanding the fact that the train arrived at Euston fourteen minutes before time.

Principal Passing Times and Speeds: 5.25 p.m. Liverpool-Euston, June 27th, 1935: load fifteen vehicles, 453 tons tare, 475 tons full. Engine 4–6–2 (Class 7), No. 6200. Driver, H. P. Smith; fireman, T. B. Pile. Weather favourable, light S.W. wind.

Miles.		Schedule.	Actual, min. sec.	Speeds.
0·0	Crewe Station .. .. dep.	0	00 00	—
1·1	Basford Wood Box .. pass	—	2 35	40
4·8	Betley Road .. .. „	—	6 47	60
8·0	Madeley .. .. .. „	—	10 06	57·7 (A)
10·5	Whitmore .. .. „	—	12 33	64·3
14·7	Standon Bridge .. .. „	—	15 53	80·4 max.
19·2	Norton Bridge .. .. „	—	19 22	Slack
21·2	Great Bridgeford .. .. „	—	20 56	80·4 max.
24·5	Stafford .. .. .. „	26	23 34	Slack
28·6	Milford .. .. .. „	—	28 10	69
33·8	Rugeley .. .. .. „	36	32 29	77·6
37·1	Armitage .. .. .. „	—	35 00	80–76
41·8	Lichfield .. .. .. „	42	38 40	76·2
48·1	Tamworth .. .. .. „	—	43 19	85·4 (B)
	Over subsidence, Polesworth — slack			
51·6	Polesworth Station .. pass	—	46 57	—
55·8	Atherstone .. .. „	—	51 05	65·2
61·0	Nuneaton .. .. .. „	60	55 21	76·2 max.
66·7	Shilton .. .. .. „	—	60 00	73·5 min.
70·0	Brinklow .. .. .. „	—	62 30	81·8 max.
75·5	Rugby Station .. .. „	73	67 09	Slack
77·8	Hillmorton Box .. .. „	—	69 56	55
82·8	Welton .. .. .. „	—	74 38	67·2 min.
88·4	Weedon .. .. .. „	—	78 47	85·4 max.
95·3	Blisworth .. .. .. „	—	84 02	75
98·2	Roade .. .. .. „	94	86 27	71·5 min.
105·7	Wolverton .. .. .. „	—	92 10	81·8 max.
111·4	Bletchley .. .. .. „	105	96 43	72–75
117·9	Leighton Buzzard .. .. „	—	102 00	72–75
122·0	Cheddington .. .. „	—	105 23	71·5
126·4	Tring .. .. .. „	119	109 16	67·2
130·1	Berkhamsted .. .. „	—	112 21	78·9
137·2	King's Langley .. .. „	—	117 25	86·6 max.
140·7	Watford .. .. .. „	—	119 55	81·8
144·8	Hatch End .. .. .. „	—	123 03	75 min.
146·7	Harrow .. .. .. „	—	124 28	81·8
150·0	Wembley .. .. .. „	—	126 52	85·4 max.
152·7	Willesden Junction, arrive	142	129 33	—

NOTES.—(A) Minimum on 1 in 177; (B) maximum at Hademore.

Following the high-speed run between Liverpool and London on June 27th, a further dynamometer car test was made with the same engine and a load of twenty vehicles (461 tons) over the more northerly section of the L.M.S. Anglo-Scottish main line on Sunday, June 30th. This test comprised a through journey from Crewe to Glasgow (Central) and back to Crewe, a total distance of 486·6 miles, and was completely successful.

The purpose of the test was to determine the capacity of this class of locomotive—of which a further ten are in course of construction at Crewe works—for sustained effort with heavy loads, particularly over the severe gradients which exist on this section of the line. In this respect especially some exceptional results were obtained, notably in the ascent of the Shap and Beattock inclines.

The distance of 37·7 miles from Lancaster to Shap Summit involves a climb from virtually sea level at Hest Bank to 915ft. above sea level at Shap Summit, and on the down journey this section was accomplished in 41¼ minutes from the Lancaster start. On the first stage of the severe part of the climb, 13 miles from below Milnthorpe to Grayrigg, of which the final 6½ miles are inclined at 1 in 104-124–131–106, the minimum speed was 43 m.p.h. A maximum of 69 m.p.h. on the level at Dillicar preceded the ascent of the Shap incline from near Tebay Station to Shap Summit box. This climb comprises 5¾ miles, of which 4¼ miles are at 1 in 75; the 5·5 miles from Tebay Station to the Summit were run in seven minutes exactly, at an average speed of 47·1 m.p.h. and with a minimum of 35 m.p.h.

The Beattock Bank proper consists of ten miles from Beattock Station to Summit box, the gradient varying between 1 in 69 and 1 in 88. This section, entered at 58·4 m.p.h. at Beattock Station, occupied 16 min. 24 sec., the average speed being 36·4 m.p.h. and the minimum 30 m.p.h.

In the up or southbound direction the approaches to both the Beattock and Shap Summits are of an easier character, although, nevertheless, involving protracted climbing. On the test run Beattock Summit (17·2 miles) was passed in 18 min. 25 sec. from leaving Symington; a maximum of 67 m.p.h. was attained at Lamington, while after falling to 57·7 m.p.h. on the 1 in 142–152 before Elvanfoot speed recovered to 64 on the level stretch through that station and fell to only 49 on the 2 miles at 1 in 99 rising to the summit.

Some equally noteworthy work was accomplished on the adverse gradients leading from Carlisle to Shap Summit; this distance of 31·4 miles was run, from the Carlisle start, in 37 min., the principal speeds being 45 m.p.h. at Wreay, 53 at Southwaite, 56 at Calthwaite, 65 on the level through Plumpton, a slack to 53 through Penrith Station, 49 at Thrimby Grange box, and 51 on the final ascent of 1½ miles at 1 in 106–130 to the summit.

Although no attempt was made to run at exceptionally high speeds during this test, the object being rather to measure the capacity of the engine on the uphill sections, a very fast run was, nevertheless, made over the 66·9

miles from Symington to Carlisle, in the southbound direction.

The 66·9 miles were covered in 59 min. 41 sec., at an average speed, start to stop, of 67·4 m.p.h., the minimum speed, as previously stated, being 49 m.p.h. at Beattock Summit, while maxima included 83·3 m.p.h. near Nethercleugh and 86·6 between Kirkpatrick and Gretna, with an intervening minimum of 66 at Castlemilk Siding. The 41·1 miles from passing summit to passing Gretna were run in 32 min. at an average speed of 77 m.p.h. This must rank as one of the fastest journeys ever made over Scottish metals.

Analysis of the dynamometer car records for the Crewe-Glasgow-Crewe tests show that coal and water consumption averaged respectively 52·6 lb. per mile coal (Grimethorpe) and 39·2 gallons per mile water, the drawbar horse-power hour working out at the excellent figure of 2·88 lb. of coal.

Weather conditions were not wholly favourable, rain being encountered on the down journey, notably between Carlisle and Beattock Summit. The locomotive crews comprised driver H. Wilkinson and fireman W. E. Robinson, of Crew North Shed, Crewe to Glasgow; and driver J. Marshall and fireman D. Crawford, of Polmadie Shed, Glasgow to Crewe; Inspector S. E. Miller (Willesden) rode on the engine throughout.

A Small Vertical Milling Machine.

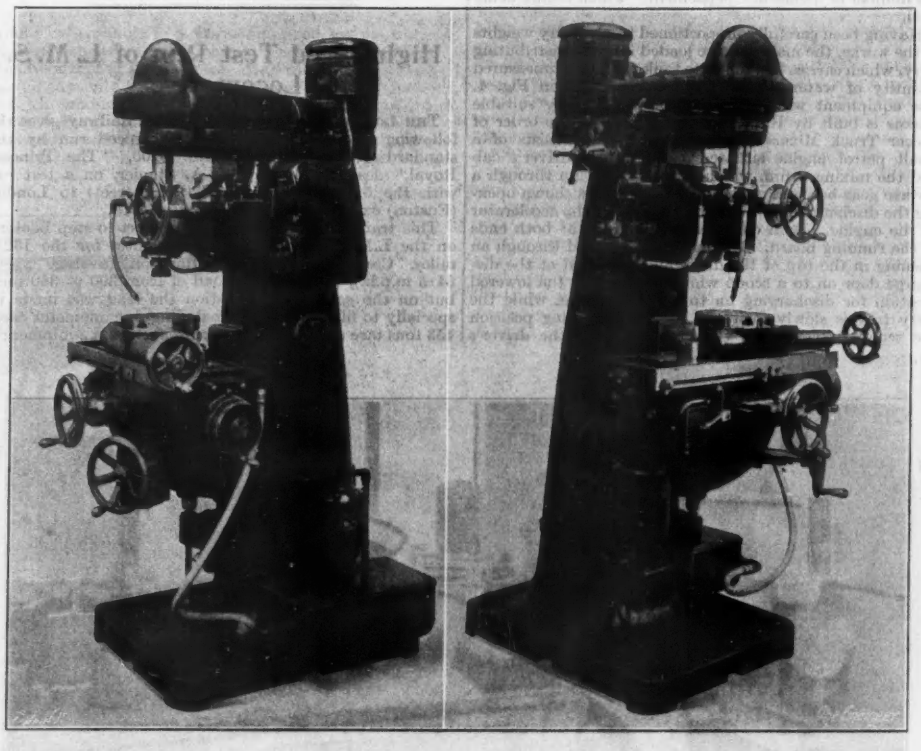
ONE of the latest products of Alfred Herbert, Ltd., of Coventry, is illustrated by the accompanying engravings. It is, it will be seen, a vertical spindle milling machine, with a self-contained motor, and is intended for working on comparatively small parts, which, nevertheless, require machining to a high degree of precision and are most conveniently worked with a vertical mill. It can be supplied with two alternative speed ranges, in three steps each, from either 106 to 1200 r.p.m. or 260 to 3000 r.p.m. It will be noticed that all the controls are conveniently placed, so that the operator can get on with his work without moving about.

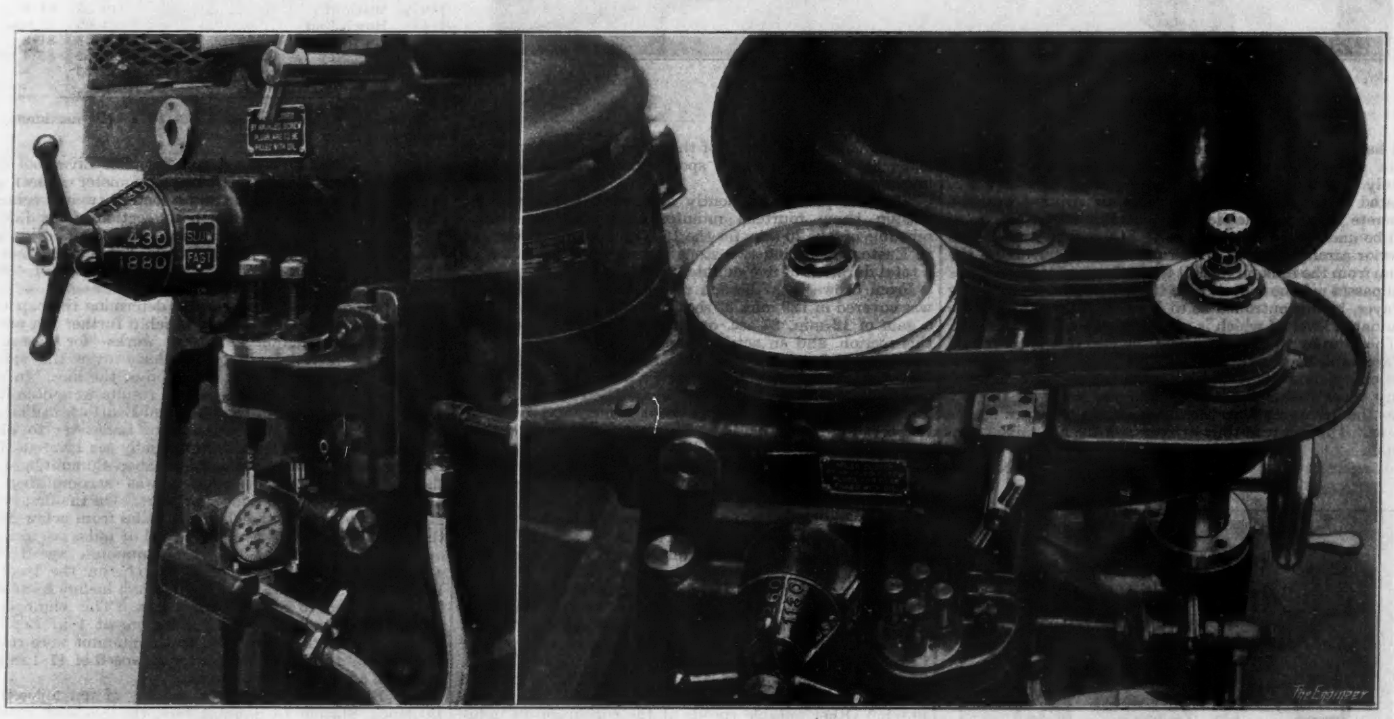
At the top of the column, which is a tapered box casting, there is bolted the driving box with the vertical flanged motor at the rear. This motor is of 2 h.p. The gear-box gives three changes of speed through chrome-nickel steel gear wheels sliding on multi-splined shafts and a V belt drive. The changes are effected by means of a pilot wheel and dial on the left-hand side of the column. The second range of speeds is obtained by changing the belt pulleys. A jockey pulley is provided for maintaining the tension in the belt.

On the front of the column there are two separate dovetail slides, one for the spindle head and one for the saddle.

SMALL VERTICAL MILLING MACHINE

ALFRED HERBERT LTD., COVENTRY, ENGINEERS





PRECISION STOPS TO SPINDLE HEAD — TEXROPE DRIVE OF SPINDLE

The saddle slides on a dovetail guide on the knee, with an adjustable gib, and the table, which has a central T slot works in a long guide, also provided with a taper gib. The saddle is moved by a screw and hand wheel, and the screw is protected by telescopic plates. As shown in an illustration, a circular table is mounted on the main table, with a worm swivelling gear. This table is 9in. in diameter. The longitudinal feed, which is automatic, is 14in. and the transverse adjustment 6¼in. The vertical movements are 7in. for the table and 3in. for the spindle. The maximum distance from the spindle to the table is 12½in. and from the spindle to the column 9½in.

The automatic longitudinal feed to the table is driven by a small reversible flanged motor bolted to the underside of the saddle apron. The latter contains the reduction gearing, and the pick-off gears by which the feed changes are obtained. The control gear for this motor is interlocked with that of the main motor, so that the spindle and feed motion start and stop together. Slow and fast feed ranges can be supplied alternatively. The feed is engaged and released by hand by a lever on the apron. The lever operates a dropping worm carried in an anti-friction worm box, which ensures a positive release. The table has two adjustable stops, by which the feed in each direction is disengaged automatically. The stops also act as dead stops after the feed is tripped. Quick hand motion for the table is obtained by an enclosed internal gear and pinion at the right-hand end. Ball bearings are used for this mechanism and for the feed screw, which ensures that the hand motion of the table is light and easy to operate.

The switchgear is enclosed in a recess near the top of the column on the right-hand side. A switch lever, having "Forward," "Off," and "Reverse" positions, is within reach of the operator from the working position. Immediately above this lever is another for controlling the direction of the table feed. These small levers give fingertip control of the machine, and the reverse position of the main switch lever can be used momentarily as a brake to stop the spindle quickly. An isolating switch with fuses is provided, and has its operating lever at the front of the column, so that the machine may be made "dead" when the pick-off gears or pulleys are being changed.

A set of four precision stops for the spindle head is provided for use where horizontal surfaces have to be machined to fine limits of height in relation to each other. A bracket carrying a rotatable cylinder is attached by bolts to the facing on the left-hand side of the spindle head. The facing has a tee-slot, so that the bracket can be adjusted vertically. The cylinder has four adjustable stop screws with lock nuts. A dial gauge is mounted on a bracket attached to the column, and when required for use can be moved into line with the position of the outer stop screw as the cylinder is indexed into the four positions. If it is required to use the stop screws as dead stops without the dial gauge, the latter can be moved backwards out of the way leaving a plain adjustable abutment in line with the position of the inner stop screw as the cylinder is indexed.

An electrically driven pump for cutting compound can be supplied, if required.

A FURTHER arterial road traffic diversion scheme for Lancashire has been discussed at Manchester between representatives of the Ministry of Transport, the Manchester and Salford Corporation, the County Councils of Lancashire and Cheshire, and the Manchester and District Regional Planning Committee. This scheme would enable road traffic along the London to Carlisle motor route to leave that highway near Hazel Grove, six miles south-east of Stockport, and to reach points in the interior of Lancashire by skirting the southern boundaries of Stockport and Manchester all the way to Trafford Park, where it would cross the ship canal by a high-level bridge, 80ft. high and estimated to cost, with approaches, £1,000,000. The new road would be called the western by-pass, to distinguish it from the eastern by-pass of Manchester, upon which work has been progressing for some considerable time.

Rail and Road.

IN view of the discussion at the Welwyn accident inquiry as to the use of steel panels in passenger vehicles, it may be noted that the two coaches concerned in the Ashton-under-Hill derailment of February 25th and the four in the Moira derailment of March 20th—both accidents were on the L.M.S.R. and the reports thereon by Colonel Mount were reviewed in our issue of July 5th—" were of modern construction, having steel underframes carrying wooden bodies covered with steel panelling and fitted with shock-absorbing buffers."

IN a speech made at Birmingham on Thursday, July 4th, Captain Austin Hudson, Parliamentary Secretary to the Ministry of Transport, said that since the war £900,000,000 had been spent on the roads of Great Britain. For a long time, he continued, the Ministry has been endeavouring, by inquiry and experiment, to find the ideal non-skid road surface, which would have a five-year life, be safe in any weather, and be light enough in colour to show up well at night. Much progress had already been made towards the desired end.

ACCORDING to the published traffic returns, the L.M.S., at the end of the twenty-sixth week, *i.e.*, the end of the half-year, earned an increase, over the corresponding period of 1934, of £299,000, or 1·04 per cent.; the Great Western an increase of £78,000, or 0·66 per cent.; and the Southern an increase of £8000, or 0·9 per cent. The London and North-Eastern, on the other hand, suffered a drop of £26,000, or 0·22 per cent. Whilst this may appear a small amount, it becomes serious when compared with the greater prosperity of the company's West Coast neighbours and even with that of the Great Western. The L.M.S. figures are the more remarkable when it is seen that the increase is nearly wholly in passenger traffic.

WHEN American interests, headed by Mr. C. T. Yerkes, came to this country at the beginning of the present century, to convert the Metropolitan District Railway to electric traction and to build new tubes, an independent concern was necessary to furnish the essential finances. That was the Metropolitan District Electric Traction Company, formed in July, 1901. In April, 1902, a new company was registered which took over the original concern. It was known as the Underground Electric Railways Company of London, and became responsible for the operation of the major part of the London underground system outside the Metropolitan Railway, but its activities ceased on the formation of the London Passenger Transport Board, and it was finally liquidated on Thursday, June 27th.

ONE of the old school of locomotive superintendents recently passed away in the death at Kilmarnock, in his ninetieth year, of Mr. James Manson, who began his railway career in the Glasgow and South-Western shops at Kilmarnock in 1861 and ended it on the same line in 1921, after he had been the G. and S.W. locomotive superintendent for twenty-two years. He came to fill the latter appointment from the similar position on the Great North of Scotland, where he had been for seven years. Railway companies were indebted to Mr. Manson for the invention, whilst on the Great North, of the arrangements whereby the electrical tablets for controlling the movements of trains over single lines could be exchanged between the engineman and signalman mechanically. That invention was not patented.

WHILST the fatal collision of June 15th at Welwyn Garden City, in which thirteen passengers and a guard lost their lives, was a much-to-be-regretted disaster, there is a sense of satisfaction in the fact that at the adjourned coroner's inquest on July 5th the jury did not consider that the accident was due to the criminal negligence of any railway servant. Evidence was given which showed that the signals were in favour of the driver of the parcels train and that the signalman at Hatfield received permission through his block instruments to send that train forward. Addressing the jury as to the terms of the verdict they had to return, the coroner said that if they were of opinion that there was neglect amounting to culpable negligence, the person responsible would be guilty of manslaughter. If they thought that the accident was due to a lapse of memory or an error of judgment and there was no gross or culpable negligence their verdict should be accidental death. After an absence of thirty-five minutes from the Court the jury returned a verdict of " Accidental death owing to a temporary lapse of memory and error of judgment on the part of the Welwyn Garden City signalman."

THE Newark brake trials, mentioned under " Sixty Years Ago," on page 641 of our issue of June 21st, was a case, as regards the Royal Commission which organised the trials, of " much cry but little wool." That body's report, issued, without a date, on February 9th, 1877, devoted one and a-half pages to the subject, but the only recommendation was in paragraph 70, which read: " We confine ourselves, therefore, to expressing our decided opinion that no train can be considered as properly equipped which is not furnished with sufficient brake power to bring it, at the highest speed at which it will be running upon any gradients within its journey, to an absolute stop within 500 yards. We have satisfied ourselves that, either by an adequate proportion of hand brakes or by the application of some one of the systems of connected or continuous brakes, there are ample means of accomplishing this object with certainty and safety, and we recommend that this be made obligatory by statute and that sufficient powers be conferred on the Board of Trade to enforce compliance with it." We would add that no such powers were given to the Board of Trade until 1889. By that time, without any compulsion, British railways had 35 per cent. of their engines and 72 per cent. of the carriages equipped with an automatic continuous brake, but the Great Northern (of Ireland), on whose line the Armagh disaster of June 12th, 1889, occurred, had a continuous brake that was not automatic in its action in the event of vehicles becoming separated. That led to the easy passage through Parliament of the Regulation of Railways Act, 1889, which made automatic continuous brakes on passenger trains, the block system, and the concentration and interlocking of points and signals compulsory.

Miscellanea.

A NEW technical college for Shrewsbury is proposed at a cost of £52,000.

WORK in connection with the erection of a television mast on one of the towers at the Alexandra Palace was begun recently.

OVER 100,000 " safety hats " are now supplied to men working in British coal mines, whereas not a single safety hat was in use four years ago.

THE flow of the Thames at Teddington is down to 400,000,000 gallons, which is below the July standard of 560,000,000 gallons, but it is about double what it was a year ago.

No fewer than 45,000 tons of limestone were blasted on Thursday, July 4th, at Buxton, in what was one of the biggest explosions the Buxton Central Quarry has ever known.

THE second exhibition of the Coal Face Machinery Exhibitors' Association is to be held at Bingley Hall, Birmingham, from September 20th to 28th. The first exhibition was held at Sheffield in 1931.

ON Thursday, July 4th, the Shrewsbury new waterworks were officially opened. They include a new reservoir holding 4,000,000 gallons, and an elevated water tower with a designed capacity of 500,000 gallons of pure water.

RECENT mineral discoveries in Russia include high-quality coal on the Pamirs; molybdenum and tungsten ores in Tajikistan; tin, copper and lead ores in Turkmenia; silver in Yakutia; and tin in Karelia; also andalusite and boron in Kazakstan.

FIFTY Glasgow tramcars are being equipped with windscreen wipers, and a number of others are to be similarly fitted before the winter. In the meantime, the Corporation is trying three kinds of windscreen wipers, operated respectively by electricity, by air, and by hand.

THE International Broadcasting Union has concluded its annual summer meeting at Warsaw. Representatives of broadcasting organisations in twenty-two European States and in the United States were present. During the session it was stated that the potential number of listeners now exceeds 200,000,000.

WORK has been begun on the Waterbury dam, the third on the comprehensive flood-control scheme for the Winooski River in Northern Vermont. It will be one of the largest earth dams in the East, having a maximum height of 150ft., and containing about 2,000,000 cubic yards of rolled filling material.

THE Ontario Minister of Mines proposes to send 25 tons of lignite coal from the Northern Ontario fields to the Department of Mines at Ottawa for testing purposes, to determine if any valuable product can be recovered from the great beds of lignite known to exist to the south of James Bay. A similar quantity may also be sent to Germany for a similar test.

THE total amount of oil fuel required by France is about six million tons, of which one million is obtained from Iraq. An effort is being made to increase the supplies of oil obtained from plants grown in French Colonies in West Africa. From each 1000 kilos. of raw oil thus obtained an output of 100 kilos. glycerine, 107 kilos heavy oil, and 343 kilos. of gas oil are won.

AN Electrodeposition Exhibition will be opened at the Science Museum, South Kensington, on July 25th, 1935. The purpose of the Exhibition is to illustrate all the phases of electrodeposition and the underlying scientific principles. The Exhibition has been organised by the Electrodepositors' Technical Society, Northampton Polytechnic Institute, London, E.C.1, from whom full information can be obtained.

A NEW method for revealing the crystallographic structure of stainless steels, devised by the United States Bureau of Standards, consists of etching electrolytically in a solution of oxalic acid—10 grammes in 100 millilitres of water. The specimen to be etched forms the anode and a piece of platinum the cathode. Current is supplied by four dry cells in series, or by a 6-volt storage battery. The solution is relatively rapid in etching action and does not, it is claimed, stain the specimen, a drawback present in almost all other methods.

THE figures given in the latest bulletin of the International Tin Research Council show that consumption of tin in manufacture during the first four months of this year was 46,400 tons, against 43,800 tons and 35,900 tons respectively in the corresponding months of 1934 and 1933. During the year ended April, 1935, the world used 132,600 tons of tin, against 138,000 tons in the previous year. The decrease of 4½ per cent. when world consumption is increasing is, the bulletin states, explained by the exceptionally heavy imports of tin into the United States during 1933.

ON Friday afternoon, July 5th, a gift of plant was made to the Ditton Laboratory of the Department of Scientific and Industrial Research. It consists of five coolers, specially made to complete the equipment of the laboratory's experimental refrigerated chambers. Three of the coolers were presented to the laboratory by Mr. S. W. Mount, of Patricksbourne, Canterbury, on behalf of a number of fruit growers who are owners of gas-stores; the other two by Lord Dudley Gordon on behalf of J. and E. Hall, Ltd., of Dartford, by whom the coolers were designed and made. Sir Frank Smith accepted the gift on behalf of the Department.

IN order to further welding research, the Engineering Foundation of America has appointed a welding research committee to initiate and conduct a critical review of world welding literature; to render aid to worthy individual projects functioning under the fundamental research committee of the American Bureau of Welding, and to sponsor specific research investigations. The scheme will be started by funds contributed by the Engineering Foundation, supplemented by funds and services supplied by industry. The project will be jointly sponsored by the American Institute of Electrical Engineers and the American Welding Society, and C. A. Adams, of Harvard University, is the chairman of the committee.

Air and Water.

THE new municipal aerodrome at Walsall was officially opened on Saturday, July 6th, by Sir William J. Talbot.

THE Suez Canal Company has decided to charge tolls in sterling instead of in gold francs. From July 8th transit dues will be at the rate of 7s. 6d. per ton.

THE first vessel to use the new Bidston Dock at Birkenhead, recently constructed at a cost of £700,000, was the " Wiiri," which brought about 4500 tons of pit props to the Mersey port for Timber and Wood, Ltd., of Rotherham, to whom adjoining land has been leased.

AT a meeting of the Joint Parliamentary Committee on Oil Pollution at the House of Commons on Monday, July 1st, it was decided to get into touch with the appropriate departments in order to press for action to decrease the oil-pollution menace round the coasts.

IT is announced by the Postmaster-General that there are now air mail despatches to South America on Wednesday and Saturday each week, instead of on Saturday only, as hitherto. Air mails despatched Wednesday will be forwarded *vid* Germany and those despatched on Saturday *vid* France.

A MUNICIPAL airport is proposed for Coventry, at Baginton, on the outskirts of the city. The preparation of the site is to be begun shortly and arrangements are being discussed with the Armstrong-Whitworth Aircraft Company, of Whitley, for the erection of hangars and other buildings.

THE first vessel to be launched on the Tyne in July was the largest cargo vessel in the world. Constructed on the electric all-welded system, the vessel is the " Joseph Medill," 295ft. in length, built by Swan, Hunter and Wigham Richardson, Ltd., of Wallsend, for the Ontario Paper Company, Canada.

A HARBOUR improvement scheme, estimated to cost £27,000, is under consideration by Anstruther Union Harbour Commissioners. When the scheme is fully prepared, the Commissioners will submit it to the Fishery Board and apply for a grant. The principal part of the scheme is the deepening of the harbour by 7ft. 6in.

LORD STRICKLAND, the former Prime Minister of Malta, proposes to ask for a Departmental Committee to be set up to consider plans and estimates for the setting up of a new air base for flying boats at Malta. This, he considers, is essential to Imperial trade and its defence. Malta, he suggests, could be made the most important flying base in Europe.

BEFORE he left for Canada on the " Empress of Britain " on Saturday, July 6th, Sir Edward Beatty, the president and chairman of the Canadian Pacific Railway, stated that an order for a sister ship, to give a better balanced service, would be placed two years prior to the withdrawal of the " Empress of Australia," and probably within five years from the present time.

PROPOSALS for the industrial development of both sides of the Thames from the Pool of London to the estuary of the river, under a representative regional Board, were discussed on Thursday, July 4th, by delegates of Essex and Kent County Councils and over twenty-six borough and district authorities. A sub-committee was formed to prepare a draft scheme for further submission.

DURING the month of June, five vessels, aggregating 23,757 gross tons, have been launched on the Clyde, bringing the total output for the year up to 92,445 tons. During the remaining half of the year there will be a considerable number of vessels put into the water, but the output for 1935 will not exceed that for 1934 (268,000 tons gross), which was, of course, augmented by the launching of the " Queen Mary." At present there is only one vessel on the stocks of over 10,000 tons gross.

ACCORDING to the Bureau Veritas list of casualties for April, forty-one steamers of 123,982 gross tons, one motor vessel of 463 gross tons, and six sailing vessels of 2211 gross tons, were broken up during the month, making a total of forty-eight vessels of 126,656 gross tons. The returns show that the total losses in April numbered sixty-seven vessels of 137,625 gross tons, including vessels broken up; of these, fifty-four of 133,131 tons were steamers, four of 975 tons motor vessels, and nine of 3519 tons sailing vessels.

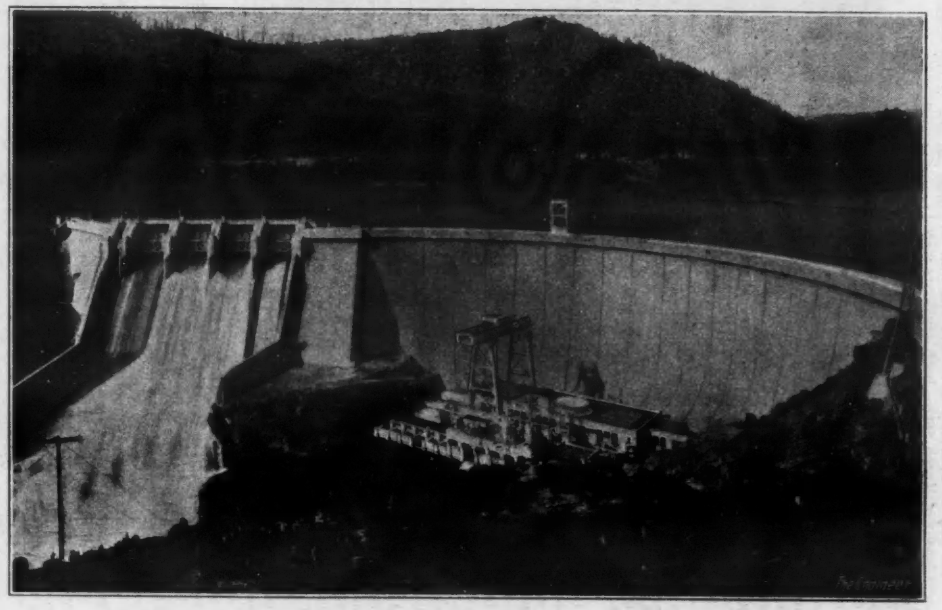
THREE new daily services between London (Croydon Airport) and Ostend and Brussels were inaugurated last week by the British Continental Airways, Ltd., which represents prominent shipping and insurance interests. The planes used are of a fast flying De Havilland type; they are very steady, and special silencing arrangements have been introduced, which enable passengers to converse with comparative ease. The aeroplanes carry six passengers, a pilot, and a wireless operator, each plane being equipped with a full-range Marconi installation.

FROM July 1st, the Southern Railway and French State Railways' steamers on the Newhaven–Dieppe route have first and third-class accommodation instead of first, second, and third-class as before. The first-class quarters on the steamers will remain first class, but both second and third-class accommodation will be allotted to third-class passengers. Second-class rail passengers will be allowed to travel in first-class accommodation on the steamer, and third-class passengers will have most of the present second and third-class accommodation at their disposal

SPEAKING at the Oil Industries Club luncheon on Tuesday, July 2nd, M. Pierre de Malglaive, resident director of the French Line in London, said that under full power, when developing about 160,000 h.p., the consumption of the " Normandie " for all purposes had been found to be about 57-60 tons of fuel oil per hour. The energy contained in 1 ton of fuel had to be liberated each minute to propel the ship over a little more than half a nautical mile. Hundreds of firemen were replaced by six electrically operated oil pumps. The general lubricating system required, roughly, 18 tons of oil, which was circulated, cooled, and purified by centrifugal cleaners. In a trip to New York and back the same oil would have been used more than 1500 times.

SOME AMERICAN ARCH DAMS

(For description see page 28.)



ABOVE: GIBSON DAM—CONSTANT RADIUS ARCH, 199 FT. HIGH
BELOW: CALLES DAM—CONSTANT ANGLE ARCH, 219 FT. HIGH

ABOVE: O'SHAUGHNESSY DAM—CONSTANT RADIUS ARCH, 344 FT. HIGH
BELOW: ARIEL DAM—CONSTANT ANGLE ARCH, 313 FT. HIGH

SIR GEORGE B. HUNTER, K.B.E., D.Sc.

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ONE-PAGE SUPPLEMENT—SIR GEORGE B. HUNTER, K.B.E., D.Sc.

NOTICES TO READERS.

**** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

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CHANGES OF ADDRESS.

**** *Will subscribers please note that in all advices regarding changes of address it is necessary to have* **both the old and new addresses,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

Pencil Portrait No. 2.

With this issue we present the second of our Pencil Portraits. It is of Sir George B. Hunter, K.B.E., D.Sc., who may be justly called the Builder of the "Mauretania."

AUTOMATIC TRAIN CONTROL AND TRACK CIRCUIT.

LAST Friday a coroner's jury decided that the railway disaster at Welwyn Garden City late on the night of June 15th was not caused by the driver of the parcels train over-running his signals, but by "a temporary lapse of memory and error of judgment on the part of the Welwyn Garden City signalman." Thus it was incorrect to assert, as was done in journals of high and low degree—but not in THE ENGINEER—that the Great Western automatic train control system would have prevented the accident, as it makes it impossible for one train to run on to the same section of line as another. Lord Monkswell is given the responsibility for the circulation of that fallacy. The *Daily Express* of Monday, June 17th, quoted him as saying so, and though, in our issue of the following Friday, we gave Lord Monkswell credit for not going as far as that, we think it possible that he mentioned the Great Western A.T.C. as a remedy against drivers ignoring adverse signals, which would have been quite in order. What added to the confusion was that in an exclusive interview with Sir Ralph Wedgwood, reported in the issue for June 19th of the same paper, Sir Ralph was stated to have said that "it is true that the G.W.R. have an automatic signalling system which perhaps is the best thing in safety. I wish we had it. Unfortunately, it costs an enormous amount of money. If only we were as wealthy as the G.W.R. we could adopt it. . . . I agree that the G.W.R. has produced a system as near absolute safety as we know." It is very evident that Sir Ralph did not see a proof of the report of this interview, for he would certainly have qualified his remarks by something to the effect that if it was found that the Welwyn disaster had been brought about by signals being disobeyed such a system of automatic control of trains as was used on the Great Western would probably have prevented the accident. Now that the coroner's jury has acquitted the signalman of any kind of criminal negligence, we are free to say that from the first, after an inspection of the line, we were satisfied that the fault was to be found elsewhere than with the driver of the parcels train; the line is straight and open, and the signals well placed and clear. Whilst we must now wait for the appearance of the report by Colonel Mount, it does seem, from the evidence given at the coroner's inquest last Friday, that the signalman at Hatfield offered the parcels train to Welwyn Garden City signalman and that it was duly accepted, but, apparently, not until the Hatfield man had questioned the arrival of the 10.53—the second portion of the 10.45. The evidence, as recorded in the Press, is not clear as to whether or not the block signals for the 10.53 were duly sent by Welwyn Garden City to Welwyn North, the next box, and it is in that connection, we suggest, that the "error of judgment" arose.

The provision by British railways of automatic train control—usually now referred to as A.T.C.—has often been discussed in these pages. In view of what has recently been written about it, it may perhaps be useful to refresh the memory of our readers as to its history and purpose. It is no new idea, but was originally offered solely as a substitute for the usual fog-signalling by detonators laid on the rails by fog-signalmen. Over and over again it was recommended in the Board of Trade reports on railway accidents—in six cases between 1889 and 1899, and in sixteen instances between 1900 and 1913. The weakness of most of the earlier inventions for mechanical fog-signalling was either that, whilst they indicated when a signal was "on," they did not provide for telling a driver when a signal was "off"—information that was necessary to him in order that he could know the state of the line ahead—or that they made no provision for the equipment on the track or on the locomotive being carried away by accident, and a driver, as a consequence, getting no adverse signal indications. What is done on the G.W.R. is to provide at the distant signal a metal ramp in the four-foot, and on the locomotive a shoe in alignment with the ramp. Within the shoe is a plunger, at the end of which there is fitted a contact maker which leads either to the engine whistle or to a bell in the cab of the locomotive. The ramp is energised, when the distant is "off," by current from the signal-box. The current flows through the plunger to the bell and rings it if the signal is "clear"; if the signal is "on," the ramp is not energised, but the plunger, when raised on passing over the ramp, causes the whistle circuit to be switched in and the whistle to sound. There is, at the same time, an application of the continuous brake, which the driver can cancel, or even forestall, when he has his train under control. The system, as yet, is applied to distant signals only and not to stop signals. It was first tried on the Fairford branch, where the ramp displaced the distant signals, and in 1908 was fixed on the main line between Slough and Reading. Now, it extends from Paddington to Plymouth, to Swansea and to Wolverhampton, and is applied to 2500 locomotives. The attitude we have consistently taken up since A.T.C. was first discussed in an accident report in 1913 is that a simple cab-signal, to indicate whether a distant is "on" or "off" is sufficient. We know that we run counter to the views of the British representatives at the last International Railway Congress in Cairo in January, 1933, and of the German delegates also; but we are supported by French opinion. We maintain that our drivers are so well trained and are so reliable that it would be sufficient for them to get a cab-signal indication when a distant was against them. We are tempted to go even farther and to say that the cost of the provision of A.T.C. is not warranted by our railway accident record. In only one of the major accidents since the Leighton Buzzard derailment of March 22nd, 1931, would A.T.C. have been useful. That was at Port Eglinton Junction on September 6th last, and would probably not have happened had junction block working been in proper operation, as the train concerned would then have been kept back at Shields-road, the next signal-box in the rear. A Departmental Committee was appointed in 1920 to investigate automatic train control and reported in 1922. For some years thereafter Sir John Pringle, the then Chief Inspecting Officer, reported each year in terms of which those in his report for 1925 are typical. Therein Sir John said: "In view of the general record for 1925, the case for the adoption of automatic train control, regarded from the point of view of safety, is less urgent in character than it was when the Committee issued their report if the financial position of the companies is considered: therefore, it does not appear that the expenditure which it would be necessary to incur in installing a method of automatic train control on British railways could justifiably be called for at the present moment." What Sir John Pringle said in his annual report for 1925 could, we suggest, be said by Colonel Mount in his forthcoming report for 1934.

We must not anticipate the report on the Welwyn accident and Colonel Mount's opinion as to the cause, and who was to blame. We are satisfied, for the moment, in showing that it was not a case of over-running signals, nor, therefore, for the adoption of A.T.C. It is, however, fairly obvious, in view of the verdict of the coroner's jury, that the fault lay in the method by which the block system was worked. Against that there is a remedy. It is comparatively costly and can only be adopted gradually. We refer to track circuiting. Broadly, it consists simply of a primary battery at the outgoing end of a section of line, which is connected to one of the pair of rails of the section, the current flowing through the contiguous rails to a relay at the ingoing end and returning through the other rails of the pair. The presence of a vehicle in the section short circuits the current through the wheels and axles. Thus the relay is de-energised and the signal for entering the section is held at "danger." Track circuiting was introduced into this country mainly in connection with the provision of automatic signalling in the first years of the present century, but the three consecutive disasters at Willesden, Hawes Junction and Coke Ovens (Pontypridd) in December, 1910, to January, 1911, showed its great value for protecting trains, engines, and vehicles which might be overlooked. Except where there is automatic signalling, *e.g.*, between Coulsdon and Brighton, and between York and Northallerton, it is not installed continuously, but in individual lengths, such as from the approach to a home signal to beyond the starting signal. The work is being done gradually, and those places where the need is greatest are dealt with first. After the serious accident at Winwick Junction on September 28th last, when a local train standing at the home signal was overlooked, and track circuit at that signal would have averted the disaster, the company's officers told Colonel Trench that whilst they agreed, and track circuit would be installed some day, "the case was low in the order of urgency in view of the proximity of the home signal to the box, and the reasonably good view of the line." At the Welwyn inquest last Friday, Mr. Barrington-Ward, the operating superintendent, was asked as to track circuit, and his reply was: "If this section was track circuited right through you could positively have only one train, but that is not the usual practice on an open section of line like this." We would, however, go farther than the provision of track circuiting on individual sections; we would have it continuous from signal-box to signal-box. Trains would then equally be protected when in the area between two boxes as between the home signal and the starting signal of one signal-box; the separation of unbraked freight trains by broken couplings would cause both portions of the train to be protected; broken rails would be at once revealed. Moreover, continuous track circuit would make cab-signalling simpler, as the indication could be given at any point. Furthermore, if British railways adopt the welding of rails, there will be fewer joints and continuous track circuit will be less costly than it now is.

Electrification on the Southern Railway.

ELECTRICAL operation of lines that now form parts of the Southern Railway has long been a matter of engineering and general interest. It began in 1909 with the conversion of the L.B. and S.C.R. South London line between Victoria and London Bridge *via* Denmark Hill. Extensions to the Crystal Palace, both from Victoria and London Bridge, were completed before 1914. Others to Coulsdon, Sutton, Eastbourne, and Brighton were authorised, but in consequence of the war it was not until 1925 that the Coulsdon and Sutton lines

were converted to electric working on the original single-phase system. The Brighton third rail scheme was not put in hand until 1930. When the London and South-Western Railway decided to electrify the Kingston roundabout and the Waterloo to Wimbledon line *via* Putney, the low-tension D.C. system was selected. Extensions were made to Shepperton, Hampton Court, and Claygate in 1916, and after the amalgamation in 1923 low-tension D.C. was chosen as standard for future conversions. Lines to Guildford and Dorking were electrified in 1925 and that to Windsor in 1930. The year 1926 marked the opening of the first section of the South-Eastern and Chatham electrification under the auspices of the Southern Railway. From that time onwards extensions of the low-voltage third rail D.C. system on the suburban lines has been progressive and culminated in February last in the opening of the two electrified routes to Sevenoaks, whilst the Sanderstead line and the Nunhead-Lewisham loop are expected to be working electrically next October. In 1929 the old L.B.S.C.R. single-phase lines were changed over to low-voltage D.C., after twenty years' operation on the original system between Victoria and London Bridge.

With the inauguration of the electrified system to Brighton and West Worthing in 1933, the long-promised main line electric service was established. The first section to Redhill, Reigate, and Three Bridges was opened on July 17th, 1932, and the Southern part of the line to Brighton and Worthing on January 1st, 1933. Last week witnessed the official opening of the extension to Lewes, Newhaven, Seaford, Eastbourne, Bexhill, Hastings, and Ore, which increases the Southern Railway Company's electrified route miles to 444 and the track miles to 1156. The newly electrified lines are those from Keymer Junction to Lewes, Lewes to Newhaven and Seaford, Lewes to Polegate and Eastbourne, Polegate to Hastings and Ore, Brighton to Lewes, and Haywards Heath to Horsted Keynes. The cost of the complete undertaking is approximately one and three quarter million pounds. In looking for the benefits that are expected to be derived from the new scheme we find that it is anticipated that the train mileage over these lines will be increased from 1,730,000 to 2,900,000 per year, an increase of 45 per cent., which naturally means more trains for the travelling public. The number of services will be increased by between 16 per cent. and over 100 per cent., with accelerated journey times varying from nine to eighteen minutes. Cheap day and monthly tickets between London and local stations are being issued to popularise the new services. Coupled with the increased comfort of travelling provided by the new rolling stock, these advantages should serve to attract more people to the South Coast. That the Southern Railway system lends itself admirably to electrification engineers have often been reminded. It has a much more uniform load throughout the day than any other system, and, as Sir Herbert Walker, the general manager, has explained, it should not be assumed that equal results could be obtained from the electrification of railways in other parts of the country or even in London.

From the point of view of electrical design the railway is also exceptional, in that relatively long distances are being covered by trains supplied with low-tension D.C. But in the absence of technical developments in sub-station design and control the economic situation would have been very different. From the beginning when the L.B.S.C.R. South London line between Victoria and London Bridge was electrified the prospect of running electric trains to Brighton was taken into account. Hence it is not to be wondered at that in those days of attended rotary converter sub-stations Sir Philip Dawson chose the single-phase system, in preference to the system that has since been adopted. What would have been entailed in the way of low-tension D.C. sub-station running costs without the arrangements now available can be gauged from the fact that on the electrified line from Croydon to West Worthing there are eighteen sub-stations, whilst the new extension has involved the provision of sixteen more and fourteen additional track paralleling huts. There are, of course, other sub-stations associated with the suburban lines, most of them, we believe, being manually operated, as on the London Underground and other D.C. railways. As the wages bill of an average attended railway rotary converter sub-station has been estimated at about £1200 per annum, it will readily be perceived that these 660-volt sub-stations have little to recommend them on main lines. But remote and automatic control of sub-stations, especially those equipped with rectifiers, has made a vast difference to operating costs. Rectifiers have led to the simplification of the control gear and to the construction of stations more akin to those associated with A.C. systems. Although it has often been said that the voltage on the Southern Railway main line extensions should have been higher than 660, the scheme adopted has the merit of permitting the use of the simple third rail throughout. Higher D.C. pressures present the disadvantages of increasing the cost of train equipments, especially those designed for 3000 volts, and of calling in most cases for an overhead conductor. Although the Southern Railway main line extensions have necessitated the erection of thirty-four sub-stations, they are controlled from two control rooms by means of simple and not unduly expensive apparatus. To put a station into service the remote operated oil switch controlling the rectifier transformer is merely closed and the auxiliary equipment comes into service automatically. The perfection with which the whole scheme works reflects considerable credit upon those who designed it. The use of rectifiers has simplified the distribution problem, and it is satisfactory to find that, unlike the rectifier equipments on the Brighton extension, those on the newly electrified lines were supplied by a British firm.

Obituary.

SIR HUGH REID.

THE British locomotive industry has suffered the severe loss of a leading figure by the death of Sir Hugh Reid, chairman and managing director of the North British Locomotive Company, Ltd., of Springburn, Glasgow. Sir Hugh, who died suddenly on July 7th at his home, "Belmont," at Springburn, was in his seventy-sixth year. He had recovered from a recent serious illness and was at business on Friday, but he had a relapse during the week-end and died on the morning of Sunday.

The family name of Reid has been an outstanding one, alike in the history of the City of Glasgow and West of Scotland industry during the last seventy-five years. The father of Sir Hugh was the late Mr. James Reid, of Auchterarder, Perthshire, who was a Lord Dean of Guild of Glasgow. Sir Hugh was born in Manchester in 1860, and was only three years of age when his father went to Springburn to assist the late Mr. Walter Montgomerie Nielson in the management of the Hyde Park Locomotive Works. In 1878 Mr. Neilson retired, leaving Mr. Reid the sole partner in the firm. His four sons were apprenticed to various branches of the industry, and in 1893 they became partners in the firm. Sir Hugh received his education at the Glasgow High School and the University of Glasgow, and was trained as an engineer at the Hyde Park Works. After the death of his father, he became the senior partner, and his association with the business continued over a period of fifty-eight years. In 1903 an amalgamation of interests between the Hyde Park Works, the Queen's Park Works, the Polmadie Works, and the Atlas Works, Springburn, was effected, and the North British Locomotive Company, Ltd., as it is now known, was constituted, with Sir Hugh as chairman. From the time of the amalgamation the firm took a leading position in the private locomotive industry of the country. Its principal business was the construction of engines, and parts of engines, to the specifications of British and foreign railways, but it undertook some ventures of its own, amongst which may be mentioned the Reid-Ramsay turbine locomotive, which in a partially completed form was shown at the Wembley Exhibition. During recent years Sir Hugh interested himself in various forms of internal combustion locomotives, and followed closely any new developments in that direction.

Throughout his career Sir Hugh showed a great interest in all movements for the beautifying of Glasgow, and the promotion of art and culture. In company with his brother, Sir John Reid, who died in January, 1933, he was associated with numerous gifts to Springburn and to the Glasgow Art Collections. He took a leading part in the life of the city and was elected Lord Dean of Guild, and in 1917 received the freedom of the city. During the war

SIR HUGH REID

years he was a member of the West of Scotland Munitions Committee of Management. From 1925 to 1929 he served as President of the Royal Glasgow Institute of Fine Arts. His University honoured his services to the City of Glasgow by conferring upon him the LL.D. degree, and in 1929 that of honorary Doctor of Laws; while his work for industry gained for him the C.B.E. in 1918 and a baronetcy in 1922. Sir Hugh was in his early days a keen Volunteer, and he served with the 1st Lanark Royal Engineers (Volunteers), and retired in 1903 with the rank of Lieutenant-Colonel. He held the Volunteer Decoration and he always took a lively interest in the work of the Territorial Army Association. He was Deputy-Lieutenant of the County of the City of Glasgow, and Brigadier of the Royal Company of Archers King's Bodyguard for Scotland. He became a member of the Institution of Civil Engineers in 1897, and served on its Council.

In the works he was one of that kind of men who find it difficult to delegate responsibility, and it may be said that practically nothing could be done at Hyde Park Works without his authority. He shone rather as an administrator than a designer, and the great position which the company has secured was undoubtedly won, very largely, by his business ability and strong personality.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

DOUGLAS CREDIT SCHEME.

SIR,—I am sure that the great majority of your readers must be grateful to you for discussing the economic situation and giving Dr. Coates an opportunity to demolish the Douglas theory.

In his first article Dr. Coates explained the orthodox economists' views very clearly, and, as shown, they appear to be unanswerable. And in his second article Dr. Coates explains Major Douglas's plan and shows its unsatisfactory character. With both of these articles I am in hearty agreement, but, nevertheless, I feel that we want some constructive guidance as well as destructive criticism.

To begin with, why is Major Douglas on the warpath at all? Surely it is because he sees a world in economic chaos and widespread misery, in spite of the fact that the great majority of its rulers are well grounded in the orthodox theories and uphold the practices which appear to follow. Major Douglas reasonably infers from this that there is a screw loose somewhere, and he thinks to trace the cause of the universal trouble to lack of purchasing power. But if, in a scientific mood, we examine where this loose screw is, I think we can easily detect the faulty construction without Major Douglas's questionable mathematics.

In the economic discussion before us, our critic has given a good and true exposition of orthodoxy, but, like most other orthodox economists, he omits all mention of the very important "snag" which is at the bottom of the trouble. Dr. Coates quite correctly says that "money is a convenient method by which goods and services are exchanged for one another." I maintain, however, that this is only true if the value of money (in goods and services) remains constant. I can readily show that if the value of money fluctuates considerably (as we all know it does), it is not only *not* convenient, but is positively disastrous in its effect of making these exchanges difficult. We are, of necessity, in the habit of fixing up long-term contracts, and if, at the time when we make these, two of A are worth £1—also three of B are likewise worth £1—then two of A will exchange for three of B readily, and will continue to do so as long as that ratio exists. But if the A goods and services are tied by long-term contracts to a fixed value in sterling, whereas the B goods and services are compelled to vary in sterling value, according to the world markets, it is very obvious that

these variations alter the ratio of values between A and B, and make it impossible to exchange them.

The A long-term contracts to which I refer are principally wages, salaries, leasehold rents, debenture and mortgage rates of interest, &c. Practically none of these can be varied much without a complete social upheaval. On the other hand, the B goods and services, which vary in sterling value according to world markets, are represented by nearly all industrial products and freights, &c.

If, then, wages, for example, remain stationary in terms of sterling at a time when prices for the products of wages are rising, it stands to reason that the *entrepreneurs* are making undue profits at the expense of the wage earners. But, on the other hand, if prices fall whilst wages remain fixed, then it is clear that the *entrepreneurs* must either trade at a loss or else shut down. This is the meaning of bad trade and unemployment.

To rectify all this, we must either make our long-term contracts (wages, &c.) elastic, to suit market prices, or else we must prevent the general price level of products from varying. This should not be done by restrictive methods, but by inflating or deflating the currency as may be necessary. I have already mentioned that it is practically impossible to vary wages, &c., and so the regulation of price level, by means of currency manipulation, is the only alternative.

The "snag" in orthodox economics is that this price level question is generally ignored, or at any rate belittled.

London, S.E.1, July 3rd. HENRY SYKES.

SIR,—Several friends, and other readers of THE ENGINEER, have written to me apparently under the impression that I am a backslider where monetary reform is concerned. I should be glad, therefore, if you would allow me to make my position clear.

I am still a hardened and unrepentant monetary reformer. Like others of my kind, I am satisfied that there is a more or less chronic shortage of purchasing power in the hands of the general body of consumers; despite orthodox statements to the effect that in the long run products pay for products, that one man's demand is another man's supply, and the assertion—repeated by parrot economists since the time of J. B. Say and J. S. Mill—that there can be no such thing as a general over-production of commodities (true only if money is regarded as also being a commodity).

Economists are very fond of statements about what happens "in the long run"—such as that in the long run machinery creates more employment than it eliminates—using this as an excuse for ignoring what happens in the short run. Assertions of that kind may be quite true and quite futile. In the long run we are all dead. In the long run all the water in the Nile finds its way to the sea; but that fact does not help anyone to deal with conditions of flood or drought, or to solve irrigation problems, or to prevent a few privileged proprietors from diverting the bulk of the water through their canals whilst the majority of canals receive a mere trickle.

Since the beginning of last century many hypotheses have been put forward to explain the general shortage of purchasing power. Most of such hypotheses contain at least a grain of truth, but none, I think, is complete in itself. Unfortunately, monetary reformers seem to be for the most part incapable of entertaining more than one idea at a time. They eagerly accept one explanation, and the manifest absurdities which too often accompany it, to the exclusion of all other explanations.

The Engineers' Economic Study Circle seems to be tackling the subject of monetary reform in the only logical way.

Finally, whilst admitting that monetary reformers are usually a bit queer in the head, I hold that most orthodox economists are raving lunatics who would be no loss to the community had they been strangled at birth. The maddest of all are those who complacently regard orthodox financial procedure as being "sound," and themselves as safe, sensible, and shrewd guardians of economic theory and practice.

London, S.W.19, July 6th. HUGH P. VOWLES.

THE "TURBOMOTIVE."

SIR,—This is a most interesting and daring experiment, and if it proves a success will upset many preconceived notions of turbine application.

The only question that arises is whether for such flexibility as is required for locomotive work of any kind, the turbine is fundamentally the right type of prime mover to employ at all, considering the absence of torque at low speed, and one cannot help wondering whether all its advantages of smooth and economical operation and absence of pounding might not have been better achieved with a multi-cylinder high-revolution steam motor and a similar gear train, modified to meet the case, with a considerable reduction in cost, since such motor would, of course, be reversible.

However, it is unfair to make any criticism so far, though one cannot help gathering from the tone of your report on the development that there were also some doubts in your expert's own mind when he wrote the article! Anything, however, that will keep out the main line electrification "disaster" is to be commended in principle, and one assumes that the engine is sufficiently close to standard type to be converted to ordinary practice without undue cost if the turbines do not come up to expectation.

All who are interested in railway matters will watch this experiment with the deepest interest, and no doubt we shall hear all about it if it is a success.

July 6th. STEAM LOCO.

Literature.

SHORT NOTICES.

Electricity and Fire Risk. By E. S. Hodges. London: Sir Isaac Pitman and Sons, Ltd. Price 10s. 6d.—An attempt is made in this book to examine the causes of electrical fires and to treat the subject of electricity and its applications from the point of view of fire hazard. It has been written in the hope that it may prove useful to surveyors, students working for the examinations of the Chartered Insurance Institute, and members of the electrical profession. Attention is drawn to many aspects of the subject which do not appear to have hitherto been brought to light in a single volume, and those who study the book should have no difficulty in appreciating the efforts of insurance officers in their attempts to ensure a maintenance of a high standard of electrical work and freedom from fire. Throughout the volume is written from the fire insurance angle, and with the exception that no reference is made to the risks that are liable to arise from static electricity, the author's treatment may be said to be adequate. Omission of this branch of the subject is not due to any lack of appreciation of its importance, but to the fact that the volume had to be kept within reasonable dimensions. A chapter covering static electricity risks was, in fact, written, but as it was found to increase unduly the size of the book it had to be omitted. It has, however, been embodied in Vol. 36 of the Chartered Insurance Institute for the benefit of those who may require guidance in this connection. In view of the ever-increasing use of electricity and the fact that in the absence of proper care electrical installations may easily give rise to fire, the book should prove a great help to all who are anxious to make electric wiring and apparatus safe, especially when studied in conjunction with the wiring rules of the Institution of Electrical Engineers.

Piles and Pile Driving. By A. C. Dean. London: Crosby Lockwood and Son, Ltd. 1935. Price 42s.—If only because there are such great differences of opinion and variations of experience in the art of making firm foundations, a book such as this volume, devoted to piles and pile driving, must be welcomed. Wisely the author has not attempted to be dogmatic. In fact, the subject demands a treatment on broad lines with frequent references to the methods by which various problems have been overcome in actual practice. In order that the book should not be too long, the author has dealt with older and better known forms of piling relatively briefly, giving, however, many references to other works in which the subject is dealt with more particularly. The descriptions of modern systems are dealt with in fuller detail. Most of the mathematics is confined to the two final chapters, dealing respectively with the Theoretical Carrying Capacity of Piles and the Stability of Walls and Coffer Dams, but it is to be found occasionally in other parts of the volume. Timber, reinforced concrete, steel bearing, sheet, dish, and screw piles are all described, and one chapter is devoted solely to the subject of pile driving. There are three appendices, one giving descriptions of various timbers used in piling work, another containing a number of tables useful for the calculation of various piling problems, and a third giving in tabular form the characteristics of some steam hammers.

Introduction to Electric Transients. By Edwin B. Kurtz and George F. Corcoran. London: Chapman and Hall, Ltd. Price 22s. 6d.—The presentation of the background necessary for the advanced study of electric transients is the object of this book, which has been prepared mainly for class work. The subject is dealt with under the headings of Physical Considerations, Mathematical Analysis, and Oscillographic Verification. Under Physical Considerations an attempt is made to present the physical aspects of the circuit conditions that are under discussion and the student is encouraged to analyse the problem in terms of the principles and laws with which he is already familiar. In dealing with mathematical analysis the authors employ Heaviside's operational calculus in addition to the conventional method of attack, and an introduction to Heaviside's calculus is given in an appendix. The actual operational solution of each circuit problem is given alongside the solution arrived at by the alternative method. Actual oscillograms accompany all the major discussions and analyses, and the agreement that exists between calculated curves and the photographic records for given circuit conditions should help to remove any doubts that may exist regarding the value of the derived expressions. Particular attention has been given to power transients which, in the opinion of the authors, have not hitherto received the consideration they demand.

Automobile and Aircraft Engines. By Arthur W. Judge. Third edition. London: Sir Isaac Pitman and Sons, Ltd. 1934. Price 42s.—It will be recollected by many that this work was first published as long as twenty years ago under the title of "High-speed Internal Combustion Engines." It has proved of such value that it has been reprinted and revised on several occasions to keep pace with the rapid progress that has taken place in the development of this class of prime mover. In the present volume, the sections dealing with Fuels for Petrol and Compression Ignition Engines, Weights and Performances of Automobile and Aircraft Engines, and with High-speed Compression Ignition Engines have been brought right up to date. At the same time certain other sections have been revised or extended.

BOOKS RECEIVED.

Your Driving Test, How to Pass It. By Oliver Stewart. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, W.C.2. Price 2s. net.

Electric Melting Practice. By A. G. Robiette, B.Sc. London: Charles Griffin and Co., Ltd., 42, Drury-lane, W.C.2. Price 15s. net.

Building Construction and Drawing. Twelfth edition. Part I, Elementary Course. By C. F. Mitchell. Revised by G. A. Mitchell, A. E. Holbrow, and A. M. Mitchell. London: B. T. Batsford, Ltd., 15, North Audley-street, W.1. Price 6s. 6d. net.

Man and the Machine. Edited by Hubert Williams. London: George Routledge and Sons, Ltd., 68–74, Carter-lane, E.C.4. Price 6s. net.

Matter and Motion. By C. H. Creasey. London: The English Universities Press, Ltd., Little Paul's House, Warwick-square, E.C.4. Price 2s. 6d. net.

Shipbuilding and Repairing in Dublin. By John Smellie, M.I.N.A. Glasgow: McCorquodale and Co., Ltd., Caxton Works. Price 6s. net.

Electrical Water Heating. By D. J. Bolton, M.Sc., P. C. Honey, and N. S. Richardson. London: Constable and Co., Ltd., 11, Henrietta-street, W.C.2. Price 7s. 6d. net.

"Hütte" Des Ingenieurs Taschenbuch. Twenty-sixth edition. Fourth Volume. Berlin: Verlag von Wilhelm Ernst and Sohn. Wilhelmstrasse 90, W.8. Price 16·50 marks.

SIXTY YEARS AGO.

A LENGTHY review of the fifth Annual Report of the Deputy-Master of the Mint published in our issue of July 9th 1875 reveals the fact that sixty years ago the Royal Mint was severely hampered in its work by the inefficiency of its machinery. All the coinage both for the United Kingdom and the Colonies came from the London Mint supplemented by its branches at Sydney and Melbourne from which gold coins only were issued. Nevertheless the coining presses in use dated from 1810 and were "more obsolete and inefficient than those of any mint in Europe, not excepting that of Constantinople." For that state, niggardliness and procrastination in high quarters outside the Mint were said by us to be responsible. So inadequate were the arrangements that it was impossible to execute coinage in more than one metal at a time. In the autumn of 1874 all operations had to be suspended for a period of six weeks while the machinery was being put in repair while for similar reasons work had been stopped for twelve weeks during the preceding year. In these unsatisfactory circumstances the officers of the Mint carried out their exacting and important work with much credit to themselves. In 1874 nearly 27½ million coins were struck with a net profit to the State of some £26,000. The moral character of our coinage as shown by the annual trial of the Pyx held at Goldsmiths' Hall was, we reported, above suspicion. The statutory standard demanded of our gold coins was 916·66 parts of fine gold per 1000, with a "remedy" or variation of two-thousandths. The trial showed that the standard had been fulfilled to within less than one-fifth of the permitted remedy. In spite of the difficulties which they had to face the officers of the Mint had found time and opportunity to pursue scientific studies. Mr. Roberts, the chemist, had for example undertaken researches on the application of the spectroscope as a means of determining quantitatively the composition of alloys particularly of gold-copper alloys. The report concluded with a section of much historical interest. Among the records of the Mint there had been found by Mr. Redington of the Public Record-Office documents extending back to the Restoration and even earlier. Included among them was a letter from Sir Isaac Newton, then Warden of the Mint, dated June 21st 1697 calling the attention of one of his deputies to information which had reached him "importing a strong Suspicion of some Fowle Play, either among the Tellers or in the Melting House, or both, whereby the Money comes out worse than heretofore."

THE INSTITUTE OF CHEMISTRY.

THIS week the Institute of Chemistry is celebrating the grant of a Royal Charter which it received fifty years ago. On Tuesday there was a great banquet at the Dorchester, which was honoured by the presence of the Earl of Athlone and Princess Alice, and by many other notables in science and politics. On Wednesday a ball was given, also at the Dorchester, and was attended by some 1500 members and guests. Another event of the week which must not pass unnoticed and which was especially mentioned at the dinner by the President, Professor Jocelyn Thorpe, was the presentation of the Frankland Medal to all still living pre-Charter fellows. The Institute came into existence in 1876, and its first President was Sir Edward Frankland. Professor Odling was the President in the Charter year, and the list of Presidents contains the names of men almost all of whom were known publicly by their works and by the distinctions they had gained. But amongst the personalities of the Institute none has done more to bring it to the great position which it now occupies than Richard Pilcher, its Registrar and Secretary, who has been its faithful servant for forty years. Responding to the toast of "The Institute," proposed by the Earl of Athlone, the President referred to Mr. Pilcher, and the cordiality with which his name was received by the large company was a clear indication of the esteem and popularity which he enjoys. In his speech, Professor Thorpe spoke of the influence upon science which the Prince Consort exercised, and expressed the opinion that if Hofmann had not been allowed to leave this country in 1865 after the death of the Prince, the aniline dye industry would never have emigrated to Germany. The other speakers of the evening were Sir Frederick Gowland Hopkins, Professor F. G. Donnan, Dr. E. L. Burgin (Parliamentary Secretary, Board of Trade), Professor Arthur Smithells, Lord Macmillan, and Sir Herbert Samuel. For the celebration Mr. Pilcher prepared a brochure on "The Early History and Progress of the Institute of Chemistry of Great Britain and Ireland," which was presented to all the diners. It traces with admirable conciseness and in felicitous language the rise and progress of an Institute which ranks in the importance of its work with any in the world.

Tungum Alloy.

ONE of the metals which has only recently come into the range of engineering materials is Tungum alloy. It is marketed by Tungum Sales Company, Ltd., of Iddesleigh House, Caxton-street, S.W.1, and possesses properties which open up an unusually wide field for its use. Its non-corrosive powers in the presence of sea water are best shown in the following figures, obtained by Dr. B. C. Laws, of 70, Victoria-street, S.W. 1, and Consultant for Research to Lloyd's Register of Shipping, a specimen of naval brass being used for comparison :—

Metal.	Hours exposed.	Loss during total immersion.	Loss by alternate immersion and emersion.
		Grs./cm.²	Grs./cm.²
Tungum	600	0·000411	0·000304
Naval brass ..	600	0·000329	0·000307
Tungum	900	0·000463	0·000361
Naval brass ..	900	0·000418	0·000427

It was observed that whereas naval brass showed a tendency to continue wasting, the wastage of Tungum metal decreased with time, reaching its maximum about three months after initial immersion and giving a figure of ·000551 grammes per square centimetre. More interesting, perhaps, than these figures are the results of the mechanical tests carried out at the same time by Dr. Laws at the University of Sheffield.

Specimen material.	Max. stress tons per sq. in.	Elongation, per cent. on 2in.	Reduction, per cent. of sec. area.	Modulus of elasticity tons per sq. in.	Stress, tons per sq. in. at 1 p.c. elongation at permanent set.
Rolled soft ..	29·82	51	62·2	7820	14·8
Rolled hard ..	46·3	17·5	49·6	8000	34·0
Forged soft ..	25·2	71·5	68·7	7830	9·0
Forged hard ..	27·68	59	71·54	7060	18·1
Casting	15·96	31	37·8	8000	4·6
Forged soft from 2in. diameter casting (not machined) ..	24·36	67	59·04	8000	6·5
Cold forged from 1in. sq. to ⅝in. sq. ..	45·2	13	50·28	6900	35·6

Bends—(a) Specimen 10in. Long.

	Diameter.	Angle of bend.	Radius.	Remarks.
	In.	Deg.	In.	
Rolled soft	1	130	1	No cracks
Rolled hard	1½	127	1½	,,
Forged soft	1	140	1	,,
Forged hard	1½	131	1½	,,

(b) Specimen 4½in. by ¾in. by ¾in.

	Angle of bend.	Radius.	Remarks.
	Deg.	In.	
Rolled soft	180	¾	No cracks
Forged soft	180	¾	,,

Torsion.

Material.	Dia.	No. of turns.	Max. shear stress, tons per sq. in.
Rolled soft	½in.	3·51	29·98
Forged soft	¾in.	10·0	29·7

The modulus of rigidity—2770 tons per square inch for rolled soft material—was also determined from a specimen 0·313in. diameter.

Alternating Bend Tests.—Carried out " in air " and in a bath of sea water on the rolled soft material, the results are given below :—

Material.	Range of stress, ± tons per sq. in.	No. of reversals.	Condition.	Remarks.
Rolled	14·27	13,201,300	Air	Unbroken
	15·0	11,812,000	,,	,,
	17·0	1,523,000	,,	Broke
Soft	9·75	24,390,300	Sea water	Unbroken
	13·56	5,977,000	,,	Broke

It may reasonably be assumed from the investigation that for 10,000,000 repetitions the safe fatigue range in air may be taken as ±15 tons per square inch and in sea water as ±11·5 tons per square inch.

Izod Tests Carried Out on Specimen of 1 Cm. Square Section.

Material.	Izod values, ft.-lb.
Rolled soft	65
Forged soft	74

Hardness Tests.—Results Obtained from Three Impressions with a 10 mm. Ball, Load 1000 kilos. for 20 Seconds.

Material.	Ball hardness.
Rolled soft	82
Rolled hard	184
Forged soft	84
Forged hard	110
Cold forged	180
Casting	56

These figures reveal that Tungum alloy has a wide range of usefulness, and this is exemplified by the fact that it is being used for the manufacture of piston rings for aircraft and also for wire ropes. A further quality of interest for boiler tube and similar applications is the thermal conductivity of Tungum, which has the property of increasing with an increase of temperature. The thermal conductivity in C.G.S. units for the following temperatures is given by Dr. Laws as :—Temperature, 50 ; conductivity, 0·17 ; 150, 0·20 ; 250, 0·23 ; 350, 0·26 ; 450, 0·28. Tests carried out by Mr. J. S. Gouch, of the Gloucester Aircraft Company, Ltd., have shown that the metal can be satisfactorily welded, soldered, or brazed with success under ordinary workshop conditions. Tungum alloy has been used for a variety of purposes ; for example, a guillotine for use in boiling caustic soda was made of it. We understand that it gave no trouble in use ; the blade retained its edge and no corrosion troubles occurred.

A Modern Foundry.

IT is not often that a foundry is to be seen which, from sand plant to fettling shop, is absolutely new. In the case of one recently opened by Winget's Ltd. at Rochester, Kent, however, the entire building and all equipment have been constructed within the last year or so, so that the whole plant is right up to date. Fig. 1 is a plan of the lay-out. Actually, such departments as core-making and fettling, are as yet incomplete in their equipment, but we understand that they are shortly to be fitted with conveyors, &c., to bring them into line with the moulding plant.

On entering the foundry the first installation to be seen is the sand conditioning mill shown in Fig. 3. This has a capacity of 30 tons per hour. There are two hoppers beneath a grating in the floor, of which one takes sand, the other coal dust. Both materials are then conveyed into a vertical elevator which passes the mixture through a screen of the revolving type. From here it drops through a 22-ton hopper on to a sand-distributing table, revolving at 3 r.p.m. A scraper deflects the mixture into the conditioning mill, where by means of both smooth and corrugated rollers in combination with deflecting fingers, the mixture is thoroughly milled. As the sand works towards the centre of the pan mill it drops on to a cross-travel conveyor, whence it is taken to the feed conveyor by an elevator. From the feed conveyor it enters a 40-ton storage bin. Further conveyors carry the sand as required from the storage bin to an elevator, which feeds it into a disintegrator, where, after being opened up thoroughly, it is dropped on to the conveyor which feeds the moulding machine hoppers. The sand is tested every hour by A F A sand-testing equipment for permeability, bond, and moisture. Surplus sand from the feeding conveyor is returned to the conditioning plant by an underground conveyor and a chute. Gratings allow sand droppings from the machines to fall on to this underground conveyor, thus keeping the floor clean. Also placed above these gratings is a jolt knock-out for emptying moulding boxes. A magnetic pulley fitted at the end of this return conveyor removes all tramp iron. All sand is of the same " facing sand " quality, no backing being used in the moulds. The conveyor belts are of vulcanised heat-resisting rubber. The mould conveyor shown in Fig. 2 consists of eighty cast iron plates, 3ft. 3in. by 4ft. 6in. long, each carried on six wheels fitted with roller bearings. There are four wheels on the main rails under each plate, and two guide wheels, which run in a central track. The

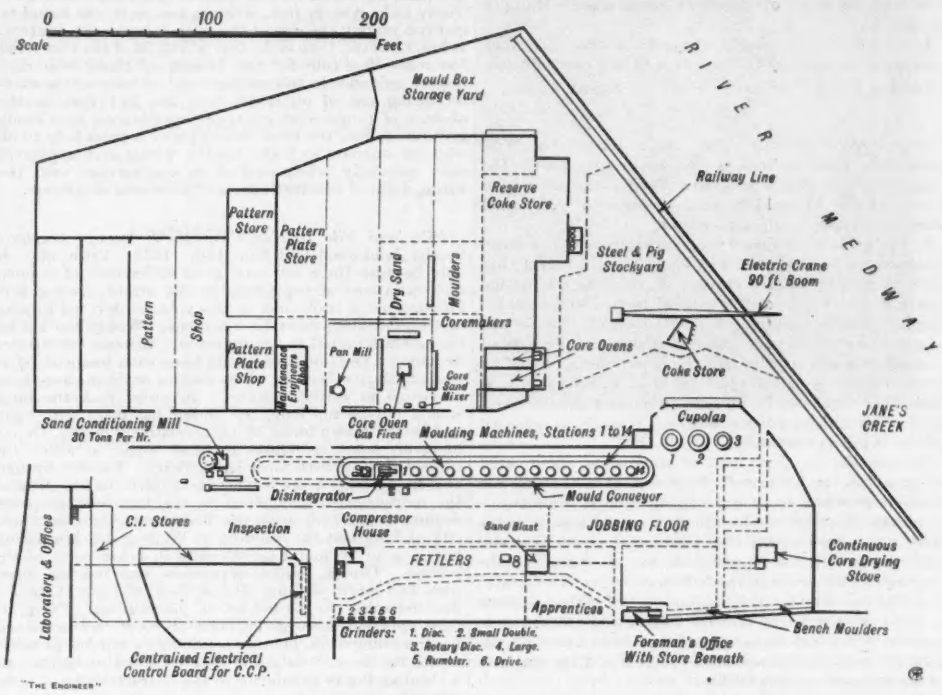


FIG. 1—PLAN OF WINGET'S FOUNDRY, ROCHESTER

FIG. 2—MOULD CONVEYOR AND MOULDING MACHINES

side tracks are parallel. The total length of conveyor is 51 yards, and the speed from 7ft. to 21ft. per minute, the variation being accomplished by a Croft variable-speed gear, which is operated by a 7 h.p. motor through reducing gear. Stations for fourteen moulding machines have been provided, eight of which are in use. As will be seen in Fig. 2, two Nicholls squeeze-jolt type machines, four hydraulic squeeze type machines of Foundry Equipment Ltd. manufacture, operating at 750 lb. per square inch pressure, one Rollover type, and one squeeze and draw type machine by the same manufacturers, using a 21½in. box, are installed. A centralised electric control is provided for the nineteen motors used in the casting plant. Here independent starters and circuit breakers are pro-

vided, together with three emergency stop buttons distributed around the plant.

In Fig. 5 the melting plant will be seen. There are one 27in. and two 36in. cupolas, the latter being built to open out to 42in. if required later. The 27in. cupola has four tuyeres and one blower mounted on the platform, while the 42in. has eight tuyeres with a deep wind belt with tangential blast. The platform is provided with compartments for scrap limestone, &c., with a total capacity of 150 tons. A 90ft. boom crane loads these from the scrap yard on the river bank below by means of a balance skip. The mono-rail which commands the cupolas is fitted with two telphers carrying large-face dial scales, which are used even if charging is done by hand. Particularly good window space is provided, giving adequate light at the cupolas. A metallurgists' bench is fitted to one side with aneroid, thermometer, &c. A Campion blast gauge is fitted to each cupola. The floor is sloped to a drain and is entirely of fireproof bricks.

The jobbing floor has constructed a large amount of the present equipment. Sand is provided by a side conveyor from the moulding plant. A number of apprentices are being trained here. They are under excellent tuition and an organised scheme provides them with theoretical classes in the evening. All knocking-out and general tidying up is carried out by a night shift, and all the moulders are on piecework. It is intended to change over the duties of the core shop and the jobbing floor, and re-equip the core shop with a continuous core-drying stove, 9ft. square by 28ft. high, having two-tier trays, 2ft. by 6ft. By changing over the location of these two shops, transport will be greatly simplified. In the present core shop the two main stoves are brick, coke-fired, one having an Acme furnace fitted. These stoves are each 9ft. by 9ft. by 20ft. In addition, there is a double-ended drying stove fired by town gas and compressed air at 10 lb. per square inch pressure, which the firm constructed itself to meet pressure of work. Mixing of oil sand is carried out in a Winget pan mill and a small mill made by Foundry Equipment, Ltd.

The fettling shop is equipped with a Tilghman sand-blasting cabinet, 8ft. cube. A rumbler, a Roberts disc double-ended grinder, a double-ended grinder with 24in. by 3in. wheels, and one with 14in. by 2in. wheels, and a 30in. Jackman surface grinder are driven by line shafting. A complete battery of pneumatic chisels is also provided.

Under the metallurgists' supervision is the alloy store, equipped with the A F A sand-testing equipment, whilst a Speedy moisture tester is kept in the chemical laboratory, which can undertake all usual tests on grey iron. An Avery testing machine is used for all physical tests.

Any reference to this foundry would be incomplete without some mention of the metal being cast therein. This is made in five grades, A, B, C, D, and E, and when cupolas are tapped an illuminated letter shown in Fig. 5 informs the moulders which metal is on tap. By this means errors are eliminated. A particularly interesting metal produced by the firm goes by the name of "Meehanite," and is a cast iron with a calcium silicide admixture. Some very interesting results have been obtained and the material has been found perfectly satisfactory, even for such work as oil engine cam shafts, which are being cast in it. Owing to the method used, the degree of surface chilling can be forecast so accurately that these cam shafts are cast with the necessary degree of hardness for each different part already there, thus avoiding further heat treatment. Even crank shafts are now being cast in "Meehanite" metal, and further developments are to be expected. We understand that the International "Meehanite" Research Institution is carrying out some interesting experiments, of which more will doubtless be heard in the near future.

FIG. 3—SAND CONDITIONING PLANT

FIG. 4—MOULD CONVEYOR

FIG. 5—MELTING PLANT

The Engineer's Ratchet Brace.

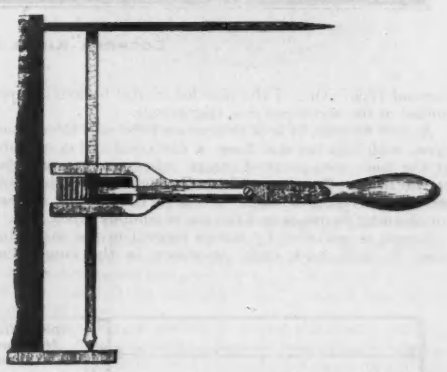
THE origin of most of our hand tools is lost in the distant past, although some of the more specialised types belong to the historic period. In some instances, we do know the date of the developed form of a tool, and in the case of the ratchet brace we are able to say that it is just a hundred years old.

The first mention of the ratchet brace with a sketch, reproduced, occurs in a letter dated August 17th, 1835, from Mr. C. Davy, an architect, to the editor of the *Mechanics' Magazine*, Vol. XXIII, 441. Under the title of "A Simple Drill," Mr. Davy says: "The above sketch represents a very simple and efficacious drill, the invention of a workman, I am informed, at Mr. Hague's manufactory. The inconvenience attached to the use of a large drill, when holes are required to be made in a confined situation, such as flanges, iron railings, &c.—it being in such cases impossible to accomplish the requisite motion—appears to have been the primary cause of this ingenious arrangement." He goes on to give a description which is too elementary to be worth quoting. As will be observed, the sketch shows no means for giving feed to the drill, and we are left to assume that there is a square hole in the ratchet wheel to take the shank of the drill.

Mr. Davy goes on to observe sententiously: "Numerous are the arrangements adopted by intelligent workmen for economising time and labour, and it is to be regretted that many of these contrivances never emerge from the workshop or factory in which they originate. Publicity would, in all probability, be the means of raising from a subordinate situation, artificers whose practical talents do honour to themselves, and reflect credit on the natural ingenuity of the working classes of this country."

John Hague was a well-known engineer and inventor, who turned out much sound work from his manufactory in Wellclose-square, Cable-street, E.1. It will be remembered that Trevithick went in 1828 to see Hague's compressed air crane at St. Katherine's Dock, and that Sir Frederick Bramwell was apprenticed to Hague.

The ratchet brace, thanks possibly to some extent to Mr. Davy, was not born to blush unseen, for an illustration of it, or rather of the ratchet lever alone, appeared in 1838 in a German periodical (*Mittheilungen des Gewerbe-Vereins für das Königreich Hannover*, 1839, page 183), under the title "Schraubenschlussel," in a paragraph headed "Communications from England," by Professor J. Schneider, who says: "It is to be met with in many English workshops, and is of great use in sundry cases." The square socket for the shank of the drill is clearly shown but no nut or other feed device.



"A SIMPLE DRILL," 1835

By 1846 the tool had got into the form familiar to us to-day, with a sleeve nut on the square-threaded feed screw and with a proper socket for the bit, because in that year John M'Mahon, a toolmaker of Fenchurch-street (the proximity of Cable-street may be remarked), registered a "double ratchet brace." The improvement consisted in the use of right and left-hand ratchets with three mitre wheels to reverse the direction of one so that almost constant rotation was given to the drill. M'Mahon's arrangement has not survived. This, by the way, is the first mention in print of the word "ratchet brace."

Holtzapffel, in his "Mechanical Manipulation," Vol. II, the preface of which is dated 1846, discusses, as one would expect, all these cognate tools (page 569). He illustrates the "common brace," the screw of which is held stationary at intervals by a tommy bar to give the feed; the "lever drill," a drill rotated by a lever like that of a vice; the "ratchet lever," which is what Mr. Davy describes above;

and, lastly, the "ratchet drill," which he derives from the lever drill, and which we now call the ratchet brace. It looks as if, in the attempt to bore holes in places inaccessible to the common brace, in the course of development the lever drill was the first idea, but no doubt it proved too slow. Then came the idea of using a ratchet, and from the ratchet lever it was but a short step to the ratchet brace.

Thus it is clear that prior to 1846 the tool had become a commercial article, and it was not necessary for a fitter to make one for himself to add to his kit. No sooner was this the case than little gadgets began to be schemed. One of the first that we have come across was the "eccentric lever brace," registered in 1847 by Joseph Fenn, toolmaker of Newgate-street (*Mech. Mag.*, XLVII, 276), in which a nipping lever is substituted for the ratchet. There has been a succession of such devices, but few have survived, and the ratchet brace to-day is substantially what it was a hundred years ago.

The Cochran-Kirke Return Tube Boiler.

ENGINEERS are so much in the habit of associating the name of Cochran, or for the matter of that the town of Annan, in Scotland, with vertical multitubular boilers that they may be almost surprised to hear that the firm has recently started making horizontal boilers. The change has been necessitated by the demand for boilers of larger capacity than can be conveniently met by the vertical type. One of the new horizontal boilers is represented in the accompanying engravings.

As will be seen, it is of the return tube or "Economic" type, with two furnace flues, a dry combustion chamber at the back, two nests of return tubes, and a smoke-box at the front. The two outstanding features of the boiler are the provision of ample access to the heating surfaces for cleaning purposes and the use of sinuous tubes.

Access is provided by waists formed in the main flues towards their back ends, as shown in the longitudinal section. These waists allow ample room for a man to crawl round and get at everything within reach. They also tend towards a turbulence in the flue gases, which promotes combustion, and accommodate expansion and contraction caused by changes of temperature. There is also a wide aisle between the two nests of tubes in which a man can comfortably stand up. Added to these means of access the tubes are spaced more widely apart than is generally the case in this class of boiler, so that cleaning tools can readily be passed between them. This feature also has the advantage that the tube plates are thoroughly cooled by the circulation of water.

The tubes, which are 2¼in. outside diameter, are bent to a sinuous form to increase their heating capacity, and it is claimed that the heat transmission is increased by 150 per cent. per unit of heating surface in this way. The waves of the tubes are arranged in the horizontal plane, so that they appear straight in elevation, and are about four diameters long. They are not very abrupt and allow a clear view from end to end, so that stiff cleaning tools can be passed straight through, but they effectively stir up the hot gases and ensure them giving up their heat rapidly. It is said that these tubes make it possible to reduce the length by 60 per cent. for any given draught drop, or alternatively, greatly to increase the weight of the gases passing through them.

In order to eliminate the possibility of leakage down the screw threads of the stay bars solid flanged forgings are used for their attachment to the boiler end plates. These forgings have blind screwed holes and their flanges are riveted to the end plates. The normal arrangement of the boiler incorporates an automatic coking stoker with self-cleaning fire-grate, which, when adjusted to run correctly in conjunction with the induced draught fan, can, it is said, be relied upon to burn any quantity of coal required up to 30 per cent. in excess of the normal rate and with as little as 25 per cent. excess air. The combustion chamber casing is of mild steel plates and forms an air-tight extension to the boiler shell. It is of ample dimensions and lined with fire-brick over a layer of insulating brick. Over the top of the flue ends are built two brick arches extending well into the combustion chamber, which ensure a maximum length of travel for the flame. Another effect of the arches is to cause an abrupt change in direction of the gases, resulting in all the light ash and grit carried over from the fires being deposited in the bottom of the casing, from which it can be removed at intervals with a rake.

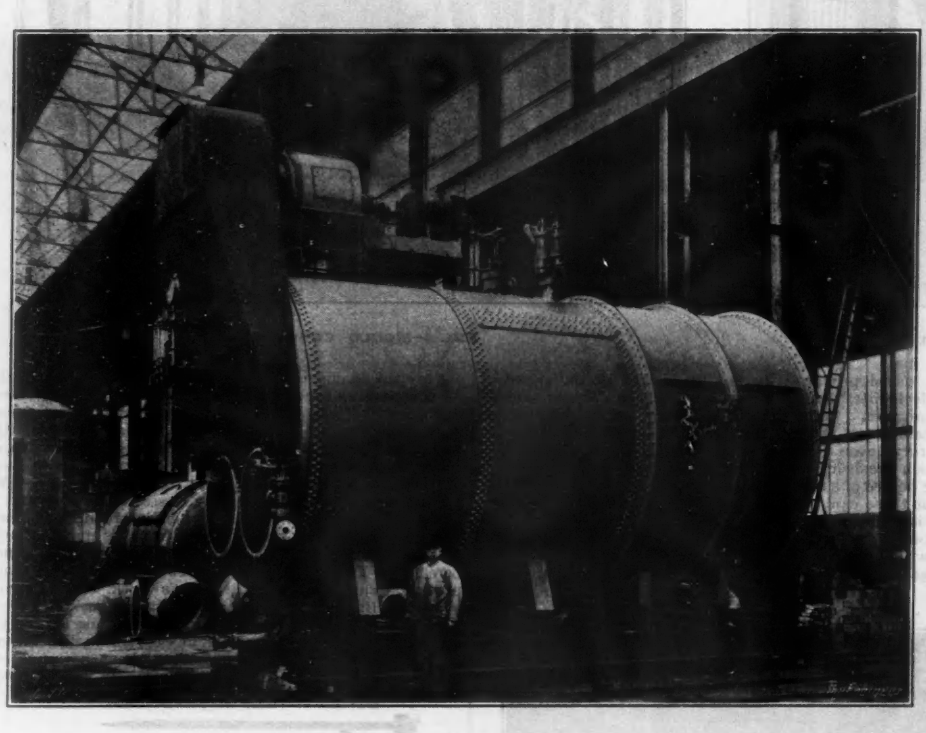
A boiler of 11ft. diameter having a normal rating of 18,000 lb. of steam per hour from and at 212 deg. Fah. was recently tested in the works, a mechanical stoker of Hodgkinson make and an induced draught fan supplied by Howden's being used. It was found that a load 30 per cent. in excess of the normal rating could be carried without the least sign of smoke even when a coal with the exceptionally high volatile content of 35 per cent. was used. The rate of firing was up to 52 lb. per square foot of grate area per hour. A full record of the composition of the flue gases was kept and it was found that by correct adjustment of fan and stoker the air could be limited to 25 per cent. in excess of that required theoretically with a complete absence of carbon monoxide.

It might be thought that some of the special features of the design would result in an increase in the draught to be provided by the fan and thereby increase the power required. Actually it has been found that the frictional resistance to the flow of gases through a "Sinuflo" tube is less than through the equivalent straight tube, *i.e.*, a straight tube that would give the same temperature drop in the gases between entry and exit; and during the tests the draught required was less than had been anticipated. No doubt the low temperature of the gases in the smoke-box and the fact that the combustion chamber casing and smoke-box are air-tight were contributory causes.

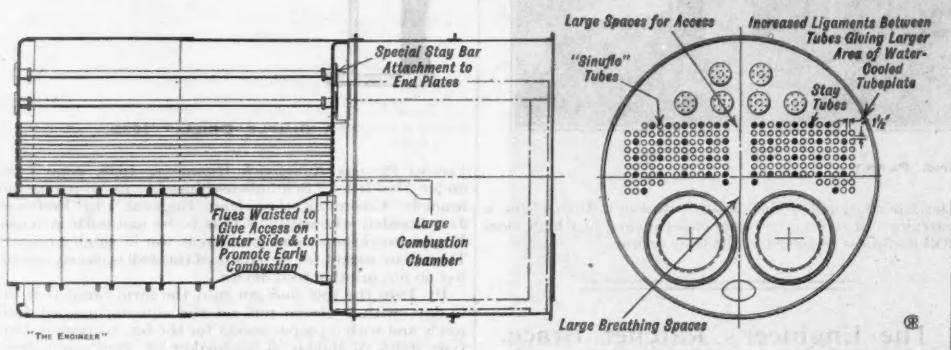
At a short demonstration carried out on May 22nd the following results were obtained at an overload of 31 per cent.:—

Duration of test	2 hrs. 30 min.
Total water evaporated	48,300 lb.
Water evaporated per hour	19,320 lb.
Temperature of feed water	53·5 deg. Fah.
Steam pressure	161 lb. per sq. in.
Equivalent evaporation per hour from and at 212 deg. Fah.	23,500 lb.
Rating of boiler	31 per cent. overload
Equivalent evaporation per hour from and at 212 deg. Fah. per square foot of heating surface	12·7 lb.
Total coal fired	5354 lb.
Coal fired per hour	2140 lb.
Coal burned per hour per square foot grate area	47 lb.
Water evaporated per pound of coal	9·03 lb.
Equivalent evaporation from and at 212 deg. Fah. per pound of coal	10·97 lb.
Coal	Fifeshire Valleyfield washed singles
Calorific value of coal as fired, gross	14,016 B.Th.U. p. lb.
Calorific value of coal as fired, net	13,581 B.Th.U. p. lb.
Thermal efficiency on gross calorific value	75·8 per cent.
Thermal efficiency on net calorific value	78·3 per cent.
Draught over fires	0·9in. water gauge
Fan suction	2·7in. water gauge
Horse-power used by fan motor	18·9

The boiler in question was 11ft. diameter with an overall length of 21ft. 7½in., designed for a working pressure of 160 lb. per square inch.



COCHRAN-KIRKE RETURN TUBE BOILER


Special Stay Bar Attachment to End Plates
Flues Waisted to Give Access on Water Side & to Promote Early Combustion
Large Combustion Chamber
"The Engineer"
Large Spaces for Access
Increased Ligaments Between Tubes Giving Larger Area of Water-Cooled Tubeplate
"Sinuflo" Tubes
Stay Tubes
1½"
Large Breathing Spaces

SECTIONS THROUGH HORIZONTAL RETURN TUBE BOILER

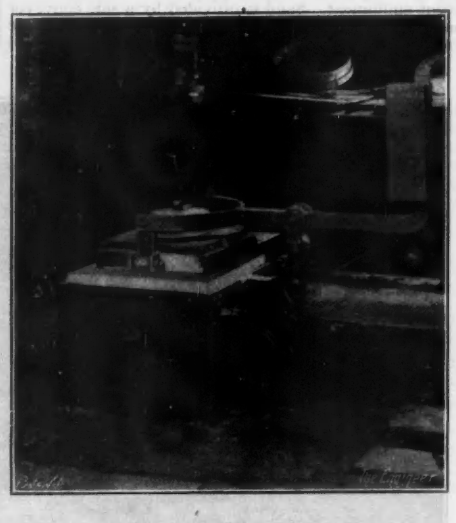
Forced Draught Coke-Fired Crucible Furnace.

IN the foundry trade, as in other branches of industry, considerable improvements have been made in technical equipment as well as in processes in recent years; witness oil and gas-fired and electrical furnaces, &c.

Strangely enough, the pit-fire survives in spite of it, and many thousands are still in use, here as elsewhere. That it is wasteful and slow in action nobody will deny; but, like everything else which conforms with traditional practice, it does not easily reliquish its hold; obviously, therefore, it must have advantages.

It was with the object of combining these advantages with greater economies and ease of working that there has just been put on to the market a remarkably efficient furnace, which might best be described as a "scientific" pit-fire. This furnace is made in two sizes, to hold a crucible for a 150 lb. and for a 250–300 lb. charge.

It consists of a rectangular steel box, lined with fire-bricks guaranteed to stand 1750 deg. Cent. About one-third of the furnace is sunk into the ground, so that it projects only to a height of about 2ft. 6in.



FORCED DRAUGHT CRUCIBLE FURNACE

Inside the furnace, about two-thirds down, there is a patented grill which consists of a square plate about 2in. thick; in the centre of this air vents lead to the top from the cavity below, whilst peripheral openings are so arranged that the air blast, forced from the blower into the sunk air-tight chamber, is evenly distributed over the surface of the crucible. The air pressure can be regulated. This grill can easily be removed, although it never requires cleaning, and the ashes can as readily be taken out from the sunk portion of the furnace.

The square opening of the furnace is covered by a brick-lined and balanced lid, which slides off horizontally and which for inspection need only be opened partially, thus preventing heat losses.

The maker, Mr. E. Cecil Kny, 19–21, Palace-street, London, S.W.1, informs us that this furnace need only be preheated for twenty minutes. The crucible is then placed upon and surrounded by a layer of coke (Marley Hill 1¼in.). In the case of the smaller size, for a charge of 150 lb., only 28 lb. to 30 lb. of coke are required for a fusion—in fact, the furnace does not hold more—and each melt never takes more than forty-five minutes. In this way eight heats per day can be obtained easily, whilst the crucible will stand up to anything between 120 and 150 heats.

Railcars for Spanish Railway.

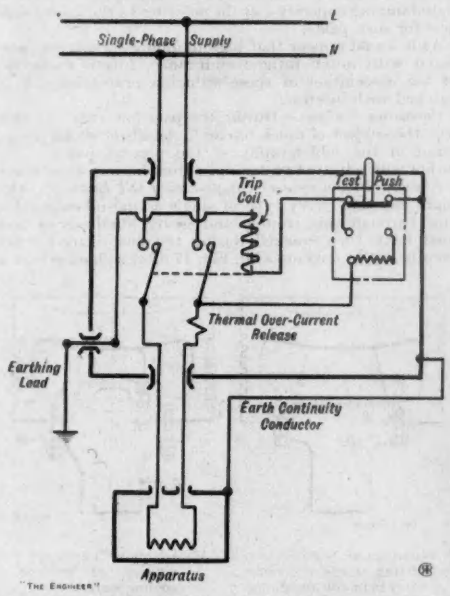
THE Beardmore-Somua-Naval railcar, illustrated in the accompanying engraving, is one of two recently built in the Nervion works at Bilbao, Spain, and supplied by the Sociedad Espanola de Construccion Naval, Madrid, to the Del Norte Railway Company. These railcars are driven by 90 h.p. Beardmore oil engines through Vulcan-Sinclair hydraulic couplings and are fitted with Clarkson exhaust gas waste heat boilers. Exclusive of passengers, each railcar has a weight of 13,675 kilos. During tests

90 H.P. OIL ENGINE-DRIVEN RAILCAR

recently carried out on the main Del Norte line between Miranda and Burgos with total loads of 16,000 kilos. the two cars successfully completed their acceptance tests and reached speeds of 90 to 102 km.p.h. They have now entered service at Oviedo.

Earth Leakage Trip Switches.

EARTH leakage trip switches introduced by A. Reyrolle and Co., of Hebburn-on-Tyne, are the outcome of extensive experimental work on the problem of the protection of rural consumers' low and medium voltage installations. They operate within the leakage unit specified in Regulation 1005 (C) of the I.E.E. Regulations for the Electrical Equipment of Buildings, and have been designed to overcome earthing difficulties in areas in which low resistance earths, such as water mains, are not available, and where the need for earth plates or stakes makes solid earthing unreliable. The switch incorporates a quick-



CONNECTIONS FOR DOUBLE-POLE SWITCH

release mechanism which comes into operation if the potential difference between the framework of the connected apparatus and earth exceeds about 25 volts A.C., and the supply is thus cut off from faults before it can become dangerous. Apart from promoting safety, the switches minimise maintenance of the distribution network by keeping leakage within reasonable limits and by speedily locating and isolating faults to earth.

The three main requirements of the average rural installation are (1) protection of a complete house circuit, (2) protection of a cooker when it represents the principal load in the house, and (3) protection of other pieces of apparatus taking currents up to 30 ampères and ranging from domestic washing machines to three-phase motors driving farm implements, &c.

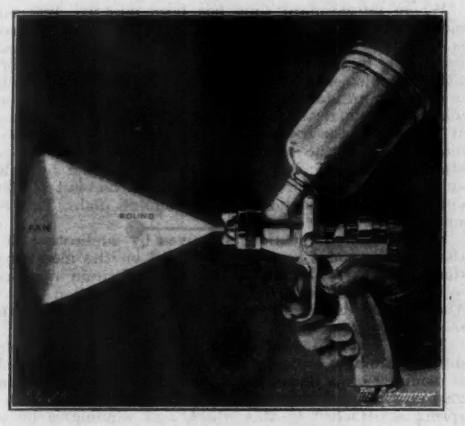
The Reyrolle cooker-control unit, and plain, double, or triple-pole switch cover this field, both having the same mechanism forming the basis of the design and consisting of a 30-ampère quick-break switch with a tripping device common to both the over current and the earth leakage releases.

Over-current protection is provided by thermal elements in both poles of double-pole units, and in two poles of triple-pole units. Settings can be varied below the normal 30-ampère rating by means of a three-position excentric control, which provides two alternative normal currents of 25 and 13 ampères when such values more nearly represent the load and protection is required against correspondingly smaller over currents. The leakage current trip coil is set to operate at about 20 or 30 milliampères, depending on the unit supplied, and can be relied upon to isolate the circuit if any stray leakage potential rises to a dangerous value as the result of high earth resistance. The diagram shows the connections for a double-pole switch for use under the conditions (1) and (3) cited above. When it is used as a cooker-control unit, the usual accessories for the auxiliary circuit are added.

Triple-pole units differ from that shown in that the leakage trip coil is connected directly in the earth circuit, i.e., in series with the earth continuity conductor, the switch casing, the test-push contacts, and the earthing lead. Any leakage current to earth caused by a fault such as failure of insulation in the apparatus will therefore pass to earth through the coil, and if large enough will trip the switch. A sustained abnormal load or a sudden short circuit will also trip the switch by the action of the thermal releases. With the aid of the test push button, which creates an artificial fault by connecting the trip coil to the line side of the circuit, through a resistance, the switch can be tested at any time, and this method of opening the switch is recommended for constant use, since it gives a regular check on the continuity of the earthing lead.

A New B.E.N. Spray Paint Gun.

A NEW spray paint gun has, we learn, been recently added to the range of products of B.E.N. Patents, Ltd., of Gorst-road, Park Royal, N.W.10. This is the "R.F." model, two types of which are being made. The "R.F." is designed for use with a gravity feed paint cup and is shown in the illustration. Three types of spray are available: a round type, or a horizontal, or a vertical fan. This variety is obtained through the use of a three-port spray head, any of the ports being brought into use by the operator rotating the spray head. In addition, three sizes

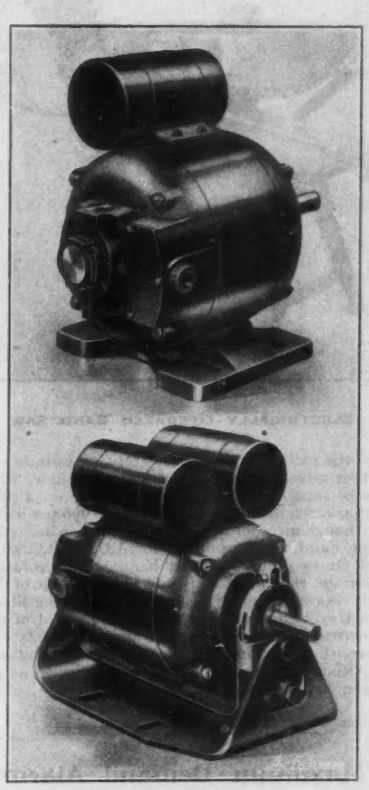


SPRAY PAINT GUN

of spray head are available, according to the amount of air required for their operation. The 4 cubic feet of air per minute size is suitable for light-bodied oil paints, stains, or lacquers. The 6 cubic feet size is for heavier-bodied paints, lacquers, aeroplane dopes, fillers, primers, bitumastic paints, and varnishes. The 8 cubic feet size is for all viscous materials, enamels, oxides, &c., where maximum speed of coverage is necessary. The gun is designed to give high application speed and is suitable for "quantity production" work. The body is a one-piece die casting of special aluminium alloy. It is easy to clean, both inside or outside, all parts being accessible, and simple to dismantle, if necessary. The air passages have been so designed that very little constriction takes place at any point and thus good atomisation is attained. The trigger has been balanced to give a light pressure. A self-aligning air control valve is fitted and the material nozzle and needle are of stainless steel. An additional variation of the model, called the "R.F.P." type, has been designed for use on a pressure container system. In this an elbow fitted to the right side of the gun admits the material. This elbow is swivelling, and it can also be used to carry the gravity cup when the gun has to be used at awkward angles. In other respects it is precisely similar to the "R.F." type. Owing to the higher pressure necessary to operate on the pressure container system, the air pressure figures show a difference, those recommended for the "R.F." type being 25 lb. to 70 lb. per square inch, while for the "R.F.P." type they are 35 lb. to 70 lb. per square inch.

Fractional Horse-Power Capacitator Motors.

To meet the demand for single-phase fractional horse-power motors capable of quiet operation and having good electrical characteristics, the British Thomson-Houston Company has introduced a range of capacitator motors. In effect they are two-phase, squirrel-cage machines, with one or two external capacitator units. They are made in two forms, known as "capacitator start" and "capacitor start-run" motors. The former has an external electrolytic condenser mouned on the top, as shown in the upper illustration, whilst the latter has two condensers, as shown in the lower illustration. Alternatively, a separately



SINGLE-PHASE CAPACITATOR MOTORS

mounted condenser and auto-transformer are employed. Although primarily developed for refrigerators, the motors are well suited for other service, necessitating long periods of service. As they are capable of giving high starting and accelerating torques, they are suitable for driving pumps, compressors, and woodworking and machine tools. Stock 50-cycle motors are designed for $\frac{1}{6}$, $\frac{1}{5}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{3}{4}$, and 1 h.p. at 200/210, 220/230, or 240/250 volts, the full-load speed being 1425 r.p.m.

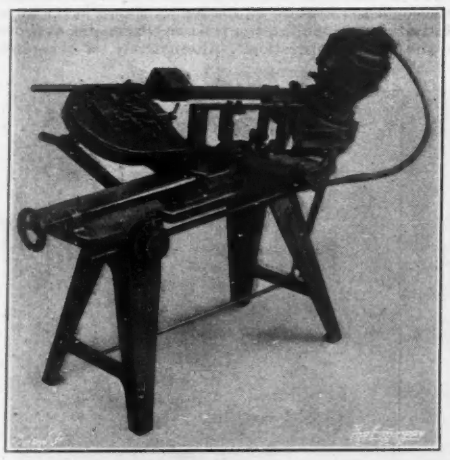
When the control switch is closed the stator winding is connected to the supply, whilst the auxiliary winding is connected in series with the external capacitator unit, which supplies the auxiliary winding with single-phase current, leading the line current by 90 deg. The equivalent of two-phase power is thus made available from a single-phase supply and a starting torque of at least three times full-load torque is obtained. As the motor accelerates the "start-run" switch inside the motor operates, thereby opening the starting contacts and closing the running contacts. In the case of the "capacitator start" motor the auxiliary winding is thereby open circuited, and the motor runs as an ordinary single-phase machine, whilst in the case of the "capacity start-run" type of machine, having two condensers, when the switch operates the second condenser is connected to the auxiliary winding, which is in circuit during the running period, and the current is adjusted to the most suitable value when the machine is running as well as when starting. When the capacitator unit consists of a condenser and auto-transformer, the transition from start to run charges the tappings on the auto-transformer, and the performance of the motor is at all times analogous to that of a two-phase machine.

The motors are supplied for rigid or resilient mounting, as shown in the upper and lower illustrations respectively. In the former case the motor has a cast base to which it is firmly secured. When resiliently mounted the motor frame floats in rubber-lined clamps forming part of the mounting cradle. This arrangement eliminates all mechanical noises and the mounting has been developed to accommodate an ingenious belt-tension-adjusting

device. In this case the bearing housing clamps are not in one piece with the cradle, but are pivoted to it, and the motor is held upright by two helical springs. When the motor is switched on electrical reaction tends to turn the stator in a direction opposite to that of the rotor, and since the stator frame is pivoted it is free to swing under this force away from the driven unit, thereby increasing the tension on the belt, which is therefore tightened to take care of the greater load at starting. Subsequently, the position of the stator frame and, therefore, the tension on the belt, are determined by the load. As the latter decreases, the belt tension is automatically reduced, and *vice versâ*, and at all times sufficient belt tension is applied to prevent slipping, thus prolonging the life of the belt and the bearings.

An Electrically-Operated Band Saw.

THE electrically operated band saw shown in the accompanying illustration has been introduced by the Crypto Electrical Equipment Company, of Acton-lane, N.W.10. Driven by a direct-geared electric motor, the machine occupies a small amount of space and offers the additional advantage of simplicity. Apart from fixing the work in the vice and starting the motor, the operation of the machine calls for no manual attention. The feed is provided automatically by gravity, and when the cut is



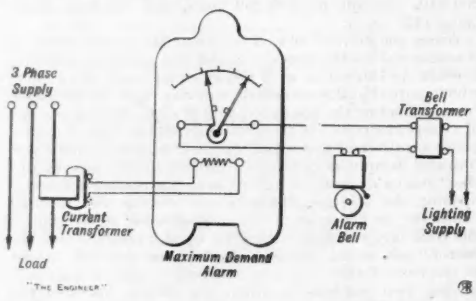
ELECTRICALLY-OPERATED BAND SAW

finished the motor automatically stops. Accurate cutting is another advantage claimed for the machine, which is said to be capable of cutting duplicate pieces of material with a variation in thickness less than 0·005 per inch.

The Langham motor, with built-in gears, runs at constant speed, and is suitable for A.C. or D.C. supplies. Carried on two Ferodo-lined band wheels rotating on ball bearings, the band saw is said to be capable of dealing with all classes of material, and to have a long life. The quick-acting vice is capable of securing metal of dimensions corresponding to the maximum capacity of the machine, which is claimed to be capable of working satisfactorily without cooling, and complications, such as pumps and pumping, are, therefore, eliminated.

Maximum Demand Alarm Indicators.

ACCIDENTAL heavy loads may result in an excessive charge for electricity, where a maximum demand tariff is in vogue. Often a heavy load, involving a correspondingly heavy charge over the whole quarter, is attributable to the unintentional coincidence of maximum loads on a number of consuming units for a short period. These loads might in many cases be arranged to occur at different times or possibly load on certain plant might be temporarily



CIRCUIT OF MAXIMUM DEMAND ALARM INDICATOR

reduced without greatly affecting the works output. Alarm indicators which give audible alarm when the load is maintained at or over any predetermined value for a period of, say, ten to fifteen minutes, depending on individual requirements, are made by Price and Belsham, Ltd., of Tamworth-lane Works, Mitcham, Surrey. As shown in the accompanying diagram, the instrument comprises an indicator with alarm contacts, a current transformer, alarm bell, and a bell transformer. The indicator has two pointers. One indicates the maximum average load for the period of the time lag, *i.e.*, fifteen to thirty minutes. The other is set by a knob on the instrument to the load at which warning is required. When the load reaches the value corresponding with the setting, contacts on the pointers close and energise the bell, which continues to ring as long as the load is maintained.

The current transformer is of the split core type, and can be fixed round the cable or bus-bar without disconnecting it. Three sets of indicators are supplied to deal with any maximum demand from 150 ampères upwards. With the exception of the transformer, all sizes are identical, and if a consumer wishes to increase the maximum load, it is merely necessary to change the transformer. The standard maximum capacities are 150, 180, 240, 360, 480, 600, 800, and 1000 ampères, with any required pointer settings down to 25 per cent. of each capacity.

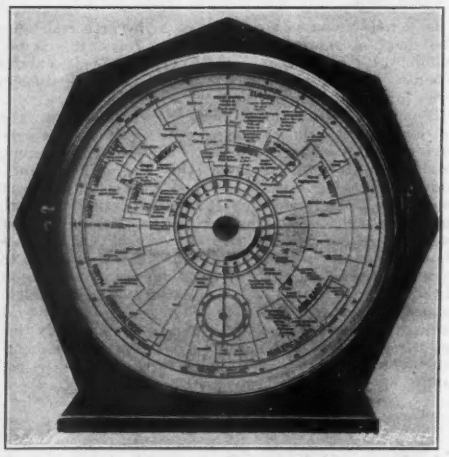
The Willis "World Clock."

A CLOCK employing an unusual form of dial, and designed to indicate the local standard time at all points of longitude, has been devised by a Norwich scientist. Whilst of simple construction, it provides a practical means of reading the hour and minute at any part of the world.

A small central dial, which rotates in an anti-clockwise direction, is divided into hours, quarters, and five-minute spacings. The hours are marked with both the A.M. and P.M. sets of twelve hours and the twenty-four-hour Continental numeration.

The broad outer ring of the dial plate is stationary, and around this are marked the main degrees of longitude, the principal oceans and seas, and the larger continents. Each is shown on its appropriate position, and the continents are outlined into blocks which serve to localise the countries and cities within their limits. The portions of the dial inside these continental blocks are shown in white, whilst the rest of the dial is tinted light blue to indicate that the titles marked thereon are those of islands. The extreme edge of the dial has a continuous blue ring, and on this appear the longitudinal divisions and the names of the oceans and larger seas.

Great Britain appears at the top of the dial, on the "0" meridian, and it will be seen that in our illustration that the time shown for this point is 12 noon. By finding



WORLD CLOCK

the line on the outer dial ring corresponding to the desired country or city, and reading the indicated time against it on the central dial, the local standard time of the appropriate point will be made available.

The smaller dial appearing below the central one is to indicate minutes of standard hours. In all standard hours the minutes are, of course, identical. It is only the numeration of the hours that differ, and this renders it possible to obtain the exact hour and minute of any country using standard time by a combined reading of both dials.

Where no standard time has been adopted, and an individual local time is in use, the country concerned is shown at a point on the dial ring which will bring its reading to the correct point on the time dial, but the title is supplemented by the number of minutes by which it differs from standard time and the necessary plus or minus sign to indicate the need for addition or subtraction. With this and the reading of the minute dial it is an easy matter to find the minutes accurately at these places also. Where a country adopts a time differing by half an hour from standard, the minutes can be read at the opposite end of the hand on the minute dial. This is suitably coloured red.

Summer time indications are given by duplicating the titles of the countries using it in red on the meridians they temporarily adopt. Thus Great Britain appears in black on meridian "0" and in red on meridian "15." The rotating dial is, therefore, equally efficient for both readings.

The mechanical construction of the clock is little different from an ordinary timepiece. The main time dial is mounted on a slotted sleeve which provides a friction grip on the fixed sleeve of the main wheel. The mainspring is attached to this wheel, and winding is by a squared arbor in the centre. The action of winding does not disturb the time setting.

The selected wheel-train ratios provide a spindle revolving once per hour, and on the lengthened front pivot of this the minute hand is frictionally mounted. Both the hour dial and minute hand are easily set.

A lever escapement of the platform type is used to control the train, thus ensuring good timekeeping, and the clock can be arranged for either eight or fifteen-day run.

An electric model, operated by a synchronous motor, and designed for use on controlled frequency alternating current supplies, and an electrically wound form for use on D.C. are also proposed.

In the standard model the dial is arranged to indicate Great Britain at the top, but for other parts of the world any alternative marking can be adopted without altering the efficiency of the clock.

The Relation of Fatigue to Modern Engine Design.*

By W. S. BURN, M.Sc.

(*Concluded from page 22.*)

Torsional Oscillation.—Great prominence has been given of late to the question of torsional oscillation, so much so that the author is inclined to think that in many cases it has been blamed when failure has been mainly due to stresses arising from some practical engine-room cause, such as uneven wear-down of bearings, have caused additional stresses which, allied to the normal twisting and bending and torsional oscillation stresses, eventually exceed the fatigue endurance range. These observations are confirmed by the periods sometimes taken for fatigue cracks to show. At any rate, cracks when they eventually do occur, do so at a stress raiser, and this again only confirms the desirability of avoiding these as far as is possible.

The assessment of what is the actual type of breaking stress in a crank shaft has in the past always been difficult, but the increased knowledge of crack form will aid the elucidation of many problems in this direction. The most important practical influence appears to be uneven alignment of the main bearings due to wear-down. With the oil engine, the latter can only occur due to engine-room neglect or accidental failure of the oil supply. When wear occurred with the steam engine a hot bearing resulted and the crank shaft simply had to be re-aligned; in the oil engine the flow of oil to the bearings is usually such as to mask the trouble and enable the shaft to run for long periods with a dangerous flexing. This indicates the importance of periodic checking of the alignment; it also looks as if in the future vibration indicators will be fitted to every large engine. There is a definite need for experiment work on specimen bars to obtain information on crack formations caused by operating specimens at their critical speeds, with and without bending and normal torque, to enable failures in practice to be elucidated.

In designing a crank shaft it must always be kept in mind that the torsional fatigue limit ($\pm$7–8 tons per square inch) is only half that of the bending fatigue limit ($\pm$14–15 tons per square inch) for ordinary steel.

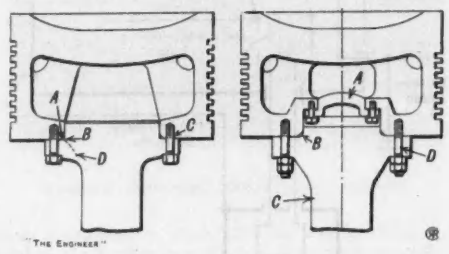
Damping Capacity.—Damping capacity *per se*, so far as most oil engines are concerned, is a property that appears to be of interest chiefly in connection with shafting, whether crank shafts or cam shafts. In this respect ordinary low-carbon steel has the highest damping capacity. Whether internal damping, *i.e.*, the capacity of the steel to absorb energy under resonance, is becoming a really vital property or not, is as yet matter for further investigation and research; but it is all in the right direction. Exact knowledge of the torsional critical speeds and the avoidance of them would appear to be the only real solution, and any serious damping necessary should be taken care of by special mechanical shaft damper of designed performance which can be under definite control. The proportion of the total damping effect due to the internal damping capacity in the steel in an average engine has been estimated as being 25 per cent. to 30 per cent. of the total damping effect, which does not seem to be sufficient to have a serious bearing on the type of steel to be used for engine parts.

Parts like the piston-rods, crossheads, and connecting-rods, which are exposed to a certain amount of ignition shock, will benefit somewhat by being made of steel of high damping capacity—again pointing to the use of mild steel for such parts.

As it would appear that high damping capacity is associated with notch fatigue endurance, future researches on the association of these valuable properties will be watched with interest.

Corrosion Fatigue.—During the past few years this has been the subject of much research, details of which can be found in the bibliography of the present paper. The author will indicate two examples from his own experience.

Flanged Piston-rods of Single-acting Oil Engines.—One might say that every type of single-acting oil engine has gone through this trouble and many hundreds of rods must have been cracked during the past fifteen years. Usually cracks develop as in Fig. 17 after a short period in



A—Inadequate sealing permitting access of cooling water to piston-rod flange
B—Sharp corner producing stress concentration.
C—Studs failed through fatigue at stress concentration under collar.
D—Corrosion fatigue fracture

A—Adequate means for prevention of leakage of cooling water.
B and C—Large fillets to reduce stress concentration.
D—Studs reduced in body to avoid fatigue failure under cyclic stress.

FIG. 17

service, due to the considerable straining action caused by the distortion of the piston when heated on which is superimposed a small cyclic stress. In some cases, when the studs were much weaker than the flange, they broke off, due to fatigue. These were then strengthened, with the result that the flanges cracked first. These in turn were strengthened at the flanges to gigantic proportions relative to the normal pressure loading.

In cases which came before the author some years ago he cured the trouble by fitting a separate flange on to the

* Abstract of Part II of a paper written under this title by R. A. MacGregor, W. S. Burn, and Professor F. Bacon, and read before the North-East Coast Institution of Engineers and Shipbuilders in Newcastle-upon-Tyne, on January 25th, 1935.

piston bottom and so eliminated the corrosion effect. He also reduced the stress raisers on the studs and flanges as shown by eliminating collars and sharp corners. In certain other engines, in spite of the stiffening of the flanges and studs, stud cracking trouble recurred and was only cured by fitting long studs and washers to give flexibility. This latter was the proper solution after elimination of the effect of the cooling water. The author has experienced no further trouble after eight years of service.

Nowadays this particular trouble is comparatively infrequent, but every now and then one hears of it cropping up in various engine types, in most cases the trouble being limited to the stretching or cracking of the studs, but occasionally having disastrous results. Most single-acting engines are now abnormally heavy about the flange and the studs due to the cause not being fully understood at the time of the trouble. The real cure is, of course, the elimination of the corrosive element, the provision of studs with adequate elasticity, and the elimination of stress concentrations of the studs and flange. One might also add, more correct piston design; but this is rather beside the point for this paper.

Piston-rods in a Double-acting Engine.—In this case the trouble occurred after two and a-half years' service. The rods were water cooled and had radial holes, as shown in Fig. 18. Corrosion fatigue occurred at the stress concentrations in the region of the radial holes. After investigation it was decided that the only real solution was to eliminate the corrosive medium. Oil cooling was therefore adopted. At the same time advantage was taken of the indications afforded by the amount of corrosion, as the amount of corrosion was roughly proportional to the stress appertaining. The portions of the rod in way of the radial holes were increased in diameter to deflect the stress flow from the hole edges and also to reduce the average stress. After three years no further corrosion has taken place in any part of the rods. Before the exact cause was realised a 35–40-ton carbon steel rod was tried in place of the 55 tons nickel steel, and it is interesting to record that although the general corrosion was much greater with the carbon steel, there was an entire absence of the localised corrosion nicks which were formed with the nickel steel. In other words, this practically indicated that the more ductile carbon steel had a less harmful stress concentration factor. Piston-rods are therefore being now made of 34–38 carbon steel and meticulously designed to avoid stress raisers.

Solution of Corrosion Fatigue.—As far as the author can see at the present time, the only real solution to corrosion fatigue is to eliminate the corrosion element completely. Corrosive fluids have no place in highly stressed engine parts, as in all cases design solutions can be found; just the ordinary observations for correct fatigue design then apply. In the future it is possible that the metallurgist may develop steels with a high corrosion fatigue endurance, but in the case of the large engine builders it is advisable to look for its presence and then eliminate the corrosion effect.

Welding-on Forged Steel Parts.—The stress-raising and crack-producing capacity of welding, especially when deposited on relatively large forged parts, is particularly potent, and a large number of engineers, including the author, must have been badly let down before it was fully appreciated. The author's worst case was in connection with the reduction in diameter of the piston-rod hole of certain oil engine crossheads by an internal layer of welding. The crossheads in question were reasonably stressed and had worked satisfactorily for over two and a-half years previously; after welding all of them develop radiating cracks from the welding after a few months' working.

A number of cases have been reported of the fracture of oil engine connecting-rods as a result of welding-on lubricating oil pipes to convey oil between the top and bottom ends, the cracking starting where the pipes were welded to the rods.

If annealing is resorted to, then all is well; but it is seldom possible or desirable to anneal a finished part. Then again, even with annealing, care must be taken to see that the actual weld is concave and not of the usual convex type, which can cause stress raisers at the sides of the weld.

Rules to be Observed in Designing.—

1. Strenuously avoid "design" stress raisers. If these must exist, use such a material as normalised low-carbon steel, which has an exceptionally high ratio of fatigue limit to tensile strength and is relatively unaffected by notches.

2. When regions of high local stress are inevitable, take special precautions that such are particularly free from workshop or corrosion stress raisers.

3. When rapid change of section is unavoidable take care that the average stress, as normally calculated, is in that region abnormally low; whenever possible use "unloading" recesses or bossings to guide the stress flow from the danger zone.

4. When special features, such as wearing or corrosion-resisting properties, are required, which frequently are associated with low fatigue strength, make use of special liners or sleeves whenever possible; in other words, articulate the parts to perform their special functions as far as practical.

We are apparently much nearer the understanding of the remarkably high "factors of safety" that have been and are being used. A more correct term should be "design factor," and as the designer becomes more sure of his real stress distribution the working stress may reasonably become correspondingly higher.

Materials Used.—One often reads that: "Due to great advances made in metallurgy it is now possible——"; it is interesting to note, however, that the improvements made during the past few years to the large marine oil engine have certainly not been due to any appreciable extent to so-called "improved" materials; rather the reverse. The modern large oil engine contains a larger proportion of low-carbon steel forgings than ever. If one excludes certain small proportions of special cast irons, stainless steels, heat-resisting steels, and hardened steels for small parts, the designer of large oil engines can well be served with low-carbon steels of from 26–38 tons tensile for all those working or highly stressed parts usually of forged steel. In fact, the advent of welded steel bedplates and columns makes the oil engine about 80 per cent. steel.

Forgings and Heat Treatment.—On the other hand, the engineer tends to become more and more careful about the heat treatment of his forgings, even though mild steel is used, with a view not only to stress relieving, but to ensure a uniform small grain size; and he will be well advised to keep an eye on this side of affairs, and to articulate to as great an extent as possible the larger parts, especially those of uneven section, which he suspects may offer any difficulties in the forging operation or heat treatment. In other words, he will be wise to simplify forging problems as far as possible. Experience seems to indicate that in practice large grain size tends to a low notch fatigue endurance limit, although there is little laboratory information in support of this; and it is here that the author would like to see comparative endurance tests made from both notched and plain polished specimens taken from pieces trepanned out from the centre of the large sections such as the crank web or journal of a large crank shaft and compared with samples from the normal Lloyd's forged-on test piece. It is most probable that researches with steels having the comparatively large grain sizes such as are commonly found in parts of large forgings would give some interesting results and perhaps explain some of the difficulties of the past. This is a point that the engineer would like cleared up, as so frequently has there

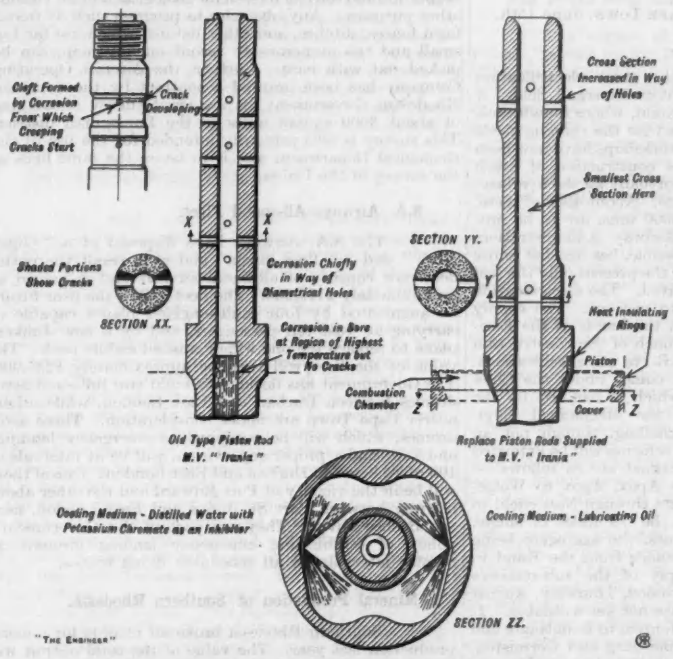


FIG. 18—*Corrosion Fatigue and Double-Acting Piston-Rods.*

been the dual misfortune of "design" stress raisers coming into the regions where the forging has not been very effective and particularly is this so in the case of large forged solid crank shafts.

The desirability of metallurgical soundness of the forging is, of course, taken for granted; obviously there must be a minimum of inclusions, or pipings.

Steel Forging Tests.—There is practical evidence of the necessity of obtaining improved forgings compared with present standards to ensure the avoidance of the combined effect of indifferent quality steel at stress concentrations and also to ensure the correct flow of the metal so that the maximum stressing is always across the grain. It would be very interesting to have fatigue tests made with notched bars from:—

1st. A mild steel ingot for a normal marine forging as cast.
2nd. When forged down to one-third of original section.
3rd. When forged down to one-sixth of original section.
4th. As 2 and 3, but also annealed.
5th. As 2, 3, and 4, but also normalised.

Associated with these tests it would also be of service to know the difference between a bar cut from across the grain and with the grain from a large section normally forged and heat-treated. Given this information, the engineer would be on very much more definite ground.

As the author feels that there will be a tendency in the future to return to the solid crank shaft for sizes up to 10in. in diameter for use in relatively high-speed single-acting engines, it is important that the manufacture of such crank shafts should be critically analysed with a view to ensuring a uniform resistance to fatigue or at any rate to ensure good fatigue resistance at known stress concentrations. Especially is it desirable to establish a combination of steel quality and heat treatment with the necessary characteristics which would lend itself to certainty of fatigue quality. Research in this direction may bring forth an improved method of heat treatment to give the steel high fatigue properties.

The Effect of the Fibre or "Grain" on Fatigue Endurance.—So far experiments have established that there is a difference in fatigue strength using plain specimens having the grain running "with" or across the bar. Across the grain appears to give about 15–20 per cent. lower value than with the grain. No experiments with notched bars appear to have been carried out.

Crystal Size—The Difference Between Large and Small Crystals.—As with the tensile strength and hardness, so there is apparently little effect on the fatigue limit when using plain polished plain cylindrical test pieces. So far, again, little or no published work has been done to ascertain the relative stress concentration factors with notched bars on mild steel bars of different structure. The author stresses this point, as cases arise in large engine work where the fracture has a definitely poor appearance, but on investigation the metallurgist is able honestly to report that the tensile and chemical properties are normal. On this account it would be of great interest to have actual notched specimens obtained from the doubtful parts of large forgings. The author believes that here is scope for real research work of interest to large oil engine builders.

The variation in the structure of the average large forging is one that the engineer has always looked upon with a certain amount of misgiving, and more recently he is fortifying himself by specifying annealing and normalising treatment to ensure small and even grain size throughout the mass.

Alloy Steels and Fatigue.—Until the engineer knows where he stands with regard to fatigue and the vast numbers of alloy steels on the market to-day, at any rate when the design departs from the plain cylindrical, he will be advised to go warily unless he has full information, not only regarding the fatigue endurance, but also of the stress concentration factors applicable to his particular designs.

Hardened Steels.—Hardened steels are not greatly used in large marine engines except for relatively small parts, such as cams and rollers with line contact, and sundry small pins and bushes in the fuel valve mechanism. Strength is seldom a vital matter and workshop stress raisers are most to be feared. As most hardened steels must be ground, they are usually of plain cylindrical form and free from untoward design stress concentrations. The most frequent failures arise from fatigue cracks which are started by faulty heat treatment, such as excessive crazy cracking, from inclusions in the steel and from excessively sharp corners left at the join of two ground surfaces at right angles. Careful inspection before use is well worth while.

Types of Fatigue Tests.—The most popular fatigue test is, apparently, the rotating alternating bending test; there is also the alternating torsion and the alternating tension and compression. Most of the research work has been done with the first type of test and the machine appears to be the most stable type, appealing to the engineer for its sound mechanical design. In this connection it is necessary for the engineer to understand the significance of the tests in relation to his actual work. It is also important that a general relationship between the various testing machines be established so that results of one type will give an indication of performance in another. Perhaps co-operation between research workers would accomplish much in this respect. Quite apart from scientific researching in Germany and America, fatigue researches are being actually utilised to a large and increasing extent by manufacturers in these countries, and defects which arise in service are dealt with by large well-equipped laboratories under experts of renown. New designs are more and more frequently submitted to the laboratories for investigation before the parts are put in hand. As has been stated elsewhere, so far there does not appear to have been much collaboration between research workers and manufacturers in this country; certainly not on the type of work engaged upon on the North-East Coast.

Scale Effect.—Before the results of laboratory fatigue testing can be directly applied to engine design, it is necessary to establish first the definite scale effect of notches and surface condition. It is noted that very recently full-size alternating bending tests have been made on drill pipes for oil wells and it was found that whereas the polished specimen gave a fatigue limit of about ±19 tons per square inch the actual pipe when tested only gave ±11 tons per square inch—a serious discrepancy.

Effect of Size on Notch Sensitivity.—Unfortunately, for applying data to large parts the information on this important point is very scanty, but there is evidence to show that the effect of size of the part is to increase the effect of notch sensitivity. Therefore the larger the part the more care must be exercised in avoiding stress concentrations of any kind. In other words, the larger the engine the more care must be exercised in design.

Quality of Surface and its Effect on Size.—Here, again, experimental data are rare, but certain experiments indicate that the larger the size of the part the greater is the effect of the finish of the surface. The type of steel will be an important factor in this respect. Any parts with known "design" stress raisers must have an extra good workshop finish.

Fatigue and Izod Notched Bar Test.—One would rather have expected that the Izod notched bar test and notched bar fatigue endurance test would have had something more in common. Such, however, does not appear to be the case, and therefore when materials are used under continuing cyclic stress, some form of notched bar fatigue test appears on this account to be the test of chief value. In marine work shock fractures occasionally occur, but chiefly due to the breakage of other parts due to some form of fatigue. It does seem desirable, however, that notch toughness and high notch fatigue endurance should be associated in the most suitable steels for highly stressed engine parts.

Overstressing Without Crack Formation.—To the designer a most remarkable property is that of the capacity of a steel to being overstressed for varying short periods beyond the safe stress when cracking should commence. This factor of "crackless plasticity" would appear to be

almost as important to the designer as a high actual fatigue endurance limit, as one reason for the designer's high factor of safety is to cope with unknown accidental heavy loading for short periods due to such causes as heavy racing, piston seizures, or other imposed abnormal stress. The time element of fatigue delay is largely an unknown quantity, but it is hoped that researches will be continued on this subject in the near future, particularly with reference to steels commonly used by local manufacturers.

Crack Spread.—There is also the phenomenon of crack spread and rate of propagation. At first this may not appear of importance to the engineer, as he may argue that once a crack appears the part would be condemned. Nevertheless, from the point of view of understanding of the fundamentals of the subject, this apparently has a most important bearing. It may be that some materials are liable to initiation of cracks, but slow to propagate the crack once formed. A steel which was not only resistant to crack initiation but also resistant to crack propagation would be very desirable indeed.

South African Engineering Notes.

(By our South African Correspondent.)

CAPE TOWN, June 15th.

Rand Electrification Scheme.

WORK has begun on the great electrification scheme for the lines along the Witwatersrand field. A start has been made at Braamfontein, where foundations and approaches are being prepared for the running sheds for the electric coaches. Special workshops have now been opened at Germiston, where the construction of much equipment will be undertaken. Virtually all the overhead masts are to be manufactured there. About 4000 of these, representing a weight of about 5000 tons, are to be produced in this plant, and the Railway Administration, desiring to be as economical as possible, has decided to use old rails as the raw material. For the present only the reef passenger trains are to be converted. The electrification programme has been divided into sections. The supply of the current to the trains is in the hands of the Electricity Supply Commission, but much of the construction will be carried out by the S.A.R. to its specifications. Preparation of the track, which comes under the Chief Civil Engineer; rolling stock, which is handled by the Chief Electrical Engineer and the Mechanical Engineers' Department; electric signalling, though not an integral part of the electrification scheme, will be extended with it. The routes to be electrified are as follows:—Johannesburg and Germiston to Apex, Apex to Welgedacht, Apex to Springs, Langlaagte through Nancefield to Pimville. Altogether there will be 78 miles of single, double, treble, and quadruple lines, the aggregate being about 200 miles, or half the distance from the Rand to Durban. Tenders for the supply of the sub-station's equipment must be submitted by noon, Thursday, August 15th. Full details of the track are not yet available. It includes a double line from Randfontein to Langlaagte and a quadruple one between Johannesburg and Germiston. The possibility of a quintuple set of rails is under consideration. Eight sub-stations will supply current at 40,000 volts, which is to be drawn from the Victoria Falls Power Company's system and will be converted to 3000 volts direct current. Four of the sub-stations are to be single units, three double, and one treble. Six months will be spent in the Union by the supervising engineer who will be sent out by the overseas manufacturers. Seventy-two motor coaches will run on the system. Of these, twenty-seven will be first class, twelve third class, and a considerable number composite in type, serving more than one class. Each coach will be 60ft. long and 9ft. 1in. wide, which compares favourably with the dimensions usual on the S.A.R. Baggage compartments will be provided and care will be devoted to securing the comfort of the driver. Trailer coaches to the number of 128 will be available. An interesting condition of the proposed contract for sub-stations, &c., is that provision must be made to prevent interference with telephone, radio, and other services near the lines. Automatic coupling is provided for and hooters, instead of whistles, operated electrically. Sound-proof construction will be embodied in the rolling stock, which must be insulated against climatic conditions. Steel bodies in order to save rattle must be integral with the underframes. Handsome lines will be provided in the exterior of the carriages, some with rounded and others with square ends. The roofs are to be done in aluminium colours.

Improving Railway Workshops.

Extensive improvements are to be carried out at the Durban railway workshops this year. These improvements, which aim at increased efficiency and greater expedition, will be put in hand as soon as drawings have been completed. The machinery at the Durban shops is out of date—some of it was installed as long as forty-two years ago—and valuable time has been lost through the distribution of work over a wide area. Provision has now been made to extend the machine shop, erect a new wheel shop, which will allow more room in wagon shops, a new tender repair shop, experimental pulverising plant for forge furnace, and to rearrange the engine stores department and yard. This work will cost a considerable amount and, in addition, £25,000 is to be spent on new and up-to-date machinery. A start with this replacement of obsolete machinery was made last year, when a similar amount was spent. Thousands of pounds are being saved by an experiment which was begun in Durban recently and which has now been adopted by all the Union Railway shops. This is the use of the jig system of constructing guards' vans, fruit and fish wagons, and vehicles which are made mainly of deal. In the past these vehicles were assembled bit by bit on their undercarriages. It was found possible, however, to save a great amount of time and labour by erecting these on jigs. By this method a complete side, roof, or end of a van is completed while it is lying on a jig and then hoisted into position complete. A recent test showed that by this means 176 screws could be screwed into position in ten minutes, the process including the drilling of holes beforehand. A guard's van can be completely assembled in eighty-two hours from the time the timber is received from the carpenters.

Aerial Survey in the Union.

The Aircraft Operating Company of Africa (Pty.), Ltd., has recently been awarded a substantial contract for aerial survey by the Geological Department of the Union. The areas to be surveyed amount in all to about 2700 square miles, comprising about 800 square miles covering the area between Sabie and Ohrigstad, and about 1900 square miles covering the Natal coalfields between Newcastle and Vryheid. The contract calls for the supply of vertical stereoscopic photographs of the area and line maps made from these photographs. The line maps will show all topographical details, such as railways, roads, tracks, rivers, towns, native villages, and so on, and they will be lined at a vertical interval of approximately 100ft. to show the relief of the country. The maps in the first place are for the use of Government geologists, but will also contain a wealth of detail which will be invaluable to those concerned in irrigation schemes, selecting the best routes for roads and every other kind of project where a reliable and detailed map of the district is the preliminary requirements. In addition, from the photographs the general nature of the ground in regard to vegetation and soil can be seen for geological and for various other purposes. Any obstacles to progress such as trees,, farm fences, ditches, and other details, which are far too small and too numerous to record on any map, can be picked out with ease. Further, the Aircraft Operating Company has been granted a contract by the Southern Rhodesian Government for an aerial survey of an area of about 3000 square miles in the Lomagundi district. This survey is also primarily intended for the use of the Geological Department and is to be on the same lines as the survey of the Union.

S.A. Airways All-metal Fleet.

The S.A. Airways have disposed of a "Gipsy Moth" and a "Puss Moth," and as a result the entire fleet now consists of all-metal aircraft and is valued at approximately £119,000. The fleet will in the near future be augmented by four multi-engined planes capable of carrying at least ten passengers, and by a new Junkers plane to replace the one which crashed awhile back. The value of the fleet will then be approximately £235,000. The Government has decided to build two full-sized aerodromes between Durban and East London, while others nearer Cape Town are under consideration. These aerodromes, which will be equipped as emergency landings and kept under proper supervision, will be at intervals of 100 miles between Durban and East London. One of them will be in the vicinity of Port Edward and the other about halfway between Port St. Johns and East London, near the Bashee River. They are part of the Government's policy of establishing emergency landing grounds at regular intervals on all scheduled flying routes.

Mineral Production of Southern Rhodesia.

Southern Rhodesia broke all records for mineral production last year. The value of the total output was £5,687,615. The gold output amounted to £4,695,746, or 82·56 per cent. of the value of the total, and was an advance of 48,653 ounces over 1933. The monthly average number of producers is given as 594, an increase of 131 over 1933. The Secretary for Mines and Public Works in his annual report states that a phenomenal increase has taken place in prospecting and pegging. But, he states, there is an inclination on the part of small workers to erect reduction plants on properties which are insufficiently developed to commence production, and such a policy has often been fatal to the prospects of the mine and has led in numerous cases to the premature closing of properties which, if developed on sound and economical lines, would have become payable producers. Since the occupation of Southern Rhodesia to December 31st last the grand total value of all minerals and precious stones produced in the Colony amounts to no less than £118,143,472.

The Victoria Falls.

The Northern Rhodesia Survey has issued a statement with regard to the dimensions of the Victoria Falls. The Survey shows the length of the Zambesi River as approximately 1700 miles, and from its source to the falls it travels 800 miles. The width at the falls, including islands, is 1909 yards; height of Devil's Cataract, 336ft.; height of main falls, 353ft.; height of Rainbow Falls, 354ft.; height of Eastern Cataract, 350ft.; height of whole falls, 347ft. The railway bridge crossing the Zambesi just below the falls at rail level above low water level is 364ft. The highest known rise of the Zambesi at gauge post is 11·45ft., and the highest known rise in the Gorge is 56ft. The maximum flood is in April and the minimum in October. The highest falls in South Africa are claimed to be in Basutoland, but the dimensions are mostly guesswork and pretty certain to be too large. In the case of the Aughrabies Falls in Bushmansland, 484 miles from Cape Town by the shortest route, *viâ* Van Rynsdorp and Granadtboskolk, the depth has been obtained with reasonable accuracy. The falls are on the Orange River and the nearest town is Kakamas, some 30 miles away. The depth is placed at 480ft. and when the Orange River is in full flood the volume of water passing over is very little inferior to that at the Victoria Falls.

Big Motor Car Imports.

While it is unlikely that last year's total of motor cars and motor buses imported, amounting to 38,000, will be equalled this year, the arrivals of motor cars each month from overseas continue to run well over 2000. January totalled nearly 2600, for February the number was 2214, for March 2588, and for April 2880. Practically America, the United Kingdom, and Canada supply the whole of the Union's requirements, as will be seen from the April figures:—America, 2110; Canada, 206; and United Kingdom, 522. In addition, 406 motor buses, lorries, trucks, and vans were imported, of which 347 came from America and 32 from the United Kingdom. Out of 214 new motor cycles imported, 203 came from the United Kingdom, nine from America, and two from other countries. United Kingdom manufacturers of motor cars should be able to increase their sales if they cultivated the market as intensively as the Americans do.

A Railway Census.

A gigantic census of every truck, van, rope, chain, and crane has been held throughout the vast network of the South African Railways and Harbours. This task, in which many clerical workers as well as station employees participated, was arranged to determine where the Administration's rolling stock and the like were at noon on Sunday, May 19th. The census will enable the control office at Johannesburg to readjust the various quotas for the different districts and also provide the Administration with accurate information on the distribution and volume of the equipment.

A NEW BRITISH CHEMICAL STANDARDS
Cr, Ni, Mo CAST IRON "K."

IN view of the increasing interest in alloy cast irons, British Chemical Standards Headquarters is now issuing the first of a series of irons containing special elements. This standard analysed sample is more or less typical of the type used for the production of specially hard cast irons by alloying and heat treatment and should be useful to chemists wishing for more information about the determination of Ni, Cr, and Mo and the effect of these elements on the determination of the ordinary constituents. The standard turnings have been carefully analysed, as usual, by a number of experienced chemists representing the different interests involved, viz., the B.C.I.R.A., independent analysts, a Government Department, a ferro-alloy manufacturer, also producers and users of alloy cast irons. The constituents standardised are as follows:—

	Per cent.		Per cent.
Total carbon ...	2·79	Sulphur	0·068
Graphitic carbon	1·99	Phosphorus ...	0·348
Combined carbon	0·80	Nickel	1·71
Silicon...	1·64	Chromium ...	0·405
Manganese ...	0·93	Molybdenum ...	0·36

It is believed that this is the only standard of its kind in Great Britain and is therefore likely to be of national interest to both independent chemists, Government chemists, and works chemists associated with the manufacture and use of alloy irons, including the aviation, motor, and engineering industries. The standard is issued in bottles containing 500 grammes, 100 grammes, 50 grammes, and 25 grammes at a price, which it is estimated, will eventually cover the cost. Each bottle is provided with a certificate showing the analysis of each chemist, together with an outline of the methods used. In particular, the method for determining molybdenum has been dealt with at some length and will no doubt be of interest.

The standard may be obtained from British Chemical Standards Headquarters (Ridsdale and Co.), 3, Wilson-street, Middlesbrough, or from any of the laboratory furnishers.

BOOKS OF REFERENCE.

Kelly's Directory of Merchants, Manufacturers, and Shippers of the World, 1935. Kelly's Directories, Ltd., 186, Strand, W.C.2. Price 64s. net.—Once again we welcome the publication of this well-known annual directory. This—the forty-ninth—edition has been revised and brought up to date, and we have no doubt that it will prove as comprehensive and accurate as the previous issues. As hitherto, it is published in two volumes, which cover the whole world. Vol. I deals with Europe, Asia, Africa, and America; Vol. II covers Great Britain and the British Empire. An interesting feature of the book is the use made of asterisks in the indexes to trades to show that in the sections where the names of towns are so marked there will be found entries of firms especially interested in world trade. Such entries are easily noticed by the fact that they are printed in more prominent type than that ordinarily used in the book.

Directory of Shipowners, Shipbuilders and Marine Engineers, 1935. Compiled under the direction of the editor of *Shipbuilding and Shipping Record*. London: The Directory Publishing Company, Ltd., 33, Tothill-street, S.W.1. Price 20s. net.—The thirty-third edition of this useful handbook has, we note, been carefully revised and covers most of the changes which during the past year have taken place in the management of shipping and shipbuilding concerns. The information it gives on the ships of the world, their owners and builders, and shipbuilding yards and marine engineering establishments of all countries makes it an indispensable aid to all who have to do with the operation, construction, or maintenance of ships.

LAUNCHES AND TRIAL TRIPS.

INVENTOR, steel screw cargo steamer; built by D. and W. Henderson and Co., Ltd.; to the order of Messrs. Thomas and James Harrison, Liverpool; dimensions, 435ft. by 56ft. by 32ft., with gross tonnage of about 6000 tons; to carry cargo. Engines, triple-expansion; constructed by the builders. Launch, July 3rd.

JOSEPH MEDILL, all-welded twin-screw motor vessel; built by Swan, Hunter and Wigham Richardson, Ltd.; to the order of the Quebec and Ontario Transportation Company, Ltd., Montreal; dimensions, 259ft. by 43ft. 10in. by 22ft.; to carry pulpwood, newsprint, and grain. Diesel engines of M.A.N. type. Launch, July 4th.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The International Steel Discussions.

Interest in the market is centred upon the negotiations between the British and Continental steel makers with regard to the proportions of the many descriptions of steel to be included in the total tonnage admitted into this country under the international agreement. The meetings last week concerned hoop and strip, steel plates and joists, but it is understood that final decisions were not reached in most cases. The representatives of the Continental steel industry were made acquainted with British views as to the tonnages which should be imported. A further meeting is to take place at the end of this week, and it is probable that definite decisions will then be made upon some of the points which were raised. There is no doubt that the Continental steel makers were disappointed by the attitude of the British in the case of one or two descriptions of steel and are inclined to argue that whilst important firms remain outside the Federation it is difficult for them to come to an agreement, small bars being a case in point. A problem which seems to be exercising the minds of both the British and Continental steel makers is the best method for controlling the imports of Continental steel. A proposal was made a week or two ago that this should be done by licence, but this idea has been abandoned and, in fact, the Federation is not in a position to issue licences which would have any authority. There are still sections of the British steel makers who would like to see all imported steel handled by the British Iron and Steel Federation; but there seems little likelihood of the Continent agreeing to this under any condition. So far as the export markets are concerned it seems that the arrangement between the British and Continental works will be simply based on the 1934 figures and that no attempt will be made to agree upon quotas for individual markets. Whilst the negotiations were proceeding between the Federation and the Cartel discussions were also taking place between the tube makers and there is some expectation that an attempt will be made to renew the international tube Cartel, which broke up a few months ago. As a result of the collapse of this organisation prices in the export markets have been cut to a ridiculous extent, and most of the contending tube industries would be glad to revert to the conditions prevailing during the lifetime of the Cartel. Difficulty, however, may be experienced in re-forming the organisation, since the industries which have secured a tonnage advantage by cutting prices would naturally expect a larger quota than at the time of the breakdown of the Cartel.

Pig Iron.

The holiday season is now affecting deliveries of pig iron. In Scotland the Falkirk and district consumers have been closed down and the break for the Glasgow holidays has checked arrivals of English iron. In Lancashire the annual stop weeks are holding up business. Producers and consumers, however, are alike in thinking that directly this season is over the demand will be on a substantial scale. The half-year has begun fairly satisfactorily. Contracts which expired at the end of June have not all been renewed and some users have covered only three months or so ahead instead of the six months for which the producers were hoping. This is principally because of the fixed belief that foundry iron prices are not likely to be advanced. The North-East Coast output is not more than enough to meet the current requirements of the foundry trade, and although it is understood that only one or two consumers have renewed contracts until the end of the year the makers are not perturbed. They are well sold over the next few months and are carrying comparatively little in the way of stocks. In fact, it is suggested that any sharp increase in demand would be difficult to satisfy. Little importance seems to be attached to export trade by the producers in this area in view of the unsatisfactory conditions ruling in many foreign markets. In June the shipments from the Tees of pig iron reached 8027 tons, compared with 9914 tons in May. Deliveries of Midland pig iron have been affected by the holidays, but before deliveries were suspended on this account the demand was active and in some cases makers were drawing upon their stocks. The renewal of contracts for the second half of the year has been disappointing and several cases are known of users carrying undelivered balances forward. Lately there have been signs of a broadening in demand, although business generally has been confined to small parcels. The light castings makers and the engineering foundries in the Midlands have certainly taken more iron than for some months past. Heavy deliveries of hematite continue to be made to the steel works and stocks at some of the producing works are reported to be getting low. The export trade, however, has been adversely affected by the difficulty of doing business with Italy owing to exchange restrictions.

The Midlands and South Wales.

Seasonal influences have retarded business to some extent in the Midlands this week, but the commencement of the holiday season has had a much less noticeable effect upon business than is usually the case. Most of the works have been operating at a high rate of production for many months, and the management at many works welcome the opportunity of overhauling plant. The outlook is regarded with confidence and consumers appear more inclined to place forward orders than at any time this year, so that in spite of the holidays a steady volume of business has continued to reach the manufacturers. This has been particularly noticeable in the case of joists and sections. Following a lull in new purchases, a sharp spurt in buying developed this week and a number of forward contracts were placed, some for substantial tonnages. This points to a maintenance of activity at the constructional engineering establishments, which have been busy the whole of this year. One of the worst features of the market is the poor demand for heavy plates. Manufacturers of this description of steel are keenly pressing for business, but there seems to be little offering of a substantial nature. The demand for small steel bars, which has been fairly good for two or three months, appears to be gathering strength. Many of the re-rollers have good forward order books and in some cases are working at capacity. The official quotation for small steel bars remains steady at £8 12s. less 2s. 6d. to 5s. rebate, with works outside the Association asking about £1 less. In the case of an important contract, however, competition between the associated and unassociated works brings their prices much closer together. There is a steady improvement in the demand for light plates and sheets; but the works specialising in thin sheets for export find conditions difficult, as the demand is principally for medium thickness sheets and light plates for the home market. The usual seasonal decline has taken place in business in colliery steel materials, but many of the manufacturers are well employed. The steel market in South Wales has developed a cheerful tone. Large outputs of structural steel are recorded and the demand for semis is increasing. The shipyards are not exceptionally busy, but there is a considerable amount of repair work in hand.

North-East Coast and Yorkshire.

The steel works on the North-East Coast appear to be reaping the full benefit of the arrangement with the Continental Steel Cartel. If anything, the volume of orders is expanding, and in one or two cases the time required for delivery has been extended. The increase in the demand for billets and sheet bars is one of the features of the market, and the works producing this class of material have sufficient orders on their books to keep them busy for some months, whilst there is no lack of new business. The shipbuilding industry on the North-East Coast does not provide the outlet for steel material which might reasonably be expected. Inquiries for new ships are in circulation, but there is considerable hesitation in placing contracts. It is understood that an order for a 9000-ton motor vessel has been placed with W. Doxford and Sons, Ltd., of Sunderland, subject to the approval of the Ships Replacement Committee. Whilst some of the works are fairly well employed in the manufacture of various classes of railway material, a number of contracts have been worked off and some of the establishments would like fresh business in rails, &c. The sheet mills are moderately busy and appear to be increasing the orders upon their books. The demand from home consumers is maintained at a good level and recently there have been some signs of expansion in business with overseas markets. Except with Empire countries, however, difficulties with regard to the remittance of money and other restrictions severely handicap business. The constructional engineering departments of the works are busy and seem able to obtain fresh orders as old ones are completed. This branch of the industry is taking a large tonnage of joists and structural steel, and it is not anticipated that there will be any relaxation in the demand for this material during the third quarter of the year. In the Yorkshire district, after a period of rather quiet trading, the demand for most classes of iron and steel has revived, and new orders are coming to hand more freely than for the past two or three weeks. The demand for acid carbon billets, which was rather quiet during the latter part of June, has strengthened somewhat this week. The works producing aircraft steel seem to be in a particularly good position and naturally expect to benefit from the Government's aircraft programme. In the Sheffield district the works making heavy forgings have good orders in hand, and the engineering industry is taking important quantities of steel. The demand for special steels is not so active as it was during the earlier part of the year, but there is no sign of any decline of business in stainless steels.

Current Business.

An order for two motor ships of 9500 tons for Cardiff owners has been secured by the Furness Shipbuilding Company, Ltd., of Haverton Hill. The vessels will be constructed under the Government's scrap and build scheme. The company is also engaged on fabricating 3000 tons of steel supplied by the South Durham and Cargo Fleet Works for the new Chelsea Bridge over the Thames. A scheme of dock development has been approved by the Clyde Navigation Trust, which will cost £7,000,000. The Argonaut Corporation, Ltd., of Glasgow and London, propose to open a new factory in the Clyde area for the manufacture of salvage equipment. The Crowgarth Iron Ore Mine, of Cleator Moor, Cumberland, has been leased by the Barrow Hematite Steel Company, Ltd., and will be reopened. The Steel Company of Scotland has secured an order for 400 tires for railway carriages and rails for the Assam-Bengal Railway. The dismantling of Bowden Close Colliery, belonging to Pease and Partners, Ltd., has been commenced. The mine has been idle for a long period. Richard Thomas and Co., Ltd., have acquired all the ordinary shares in Monks Hall and Co., Ltd., manufacturers of steel bars, strip, and tubes. The Fairfield Shipbuilding and Engineering Company, Ltd., of Chepstow, has been awarded contracts for the steel work for three new aerodromes to be built under the Government's expansion programme. The Uskside Engineering Company, Ltd., Newport, Mon., are working upon orders for eleven electric hoists for South African gold mines. Five vessels, totalling 26,153 tons, were launched on the Clyde in June. In the six months ending June 30th vessels aggregating 94,841 tons were launched, compared with twenty-two vessels of 31,105 tons for the first half of 1934. The Department of Overseas Trade reports that the following contracts are open for tender:—South African Railways and Harbours: one 60-ton steam travelling breakdown crane (Johannesburg, August 26th); a 36-ton steam travelling breakdown crane (Johannesburg, August 19th); Egyptian Ministry of Public Works: ball and roller bearings required for the year 1935–36 (Cairo, July 29th); Indian Stores Department, Engineering Section, Simla: one cold starting crude oil engine-driven vertical spindle tube well turbine pumping plant with geared head capable of delivering 15,000 gallons per hour against a total head of 70ft. (India, July 23rd); steel lighter of 100 tons capacity for the Engineer and Harbour Master, Port Blair (Simla, August 15th); South African Railways and Harbours Administration: seamless copper pipes for locomotives (Johannesburg, August 12th).

The Polish Steel Trade.

The review of the "Economic Conditions in Poland," issued by the Department of Overseas Trade for 1934, is of more than usual interest from the fact that an Anglo-Polish commercial agreement was entered into in February last year and that, so far, the Polish iron and steel industry has remained outside the European Steel Cartel. By the commercial agreement tariff concessions were made by Poland on 400 different items and, in spite of the diminished total value of imports into that country from all sources, imports from Great Britain increased from 83 million zlote to 86·2 millions. The value of Polish exports to this country, however, also increased from 184·7 million zlote to 191·9 million, and this increase formed a substantial part of the total Polish favourable balance. The report points out that a feature of the year has been the extension of State control over industry. The Government gained a footing in the heavy industries as a result of the collapse of 1932 and has since extended its influence. At the moment practically all the steel producers in Polish Upper Silesia are either under Government control or influence and the Government has also important interests in the coal industry. The production of iron and steel materials in Poland increased during 1934, particularly of pig iron and tubes. In the former it rose from 306,000 tons to 381,000 tons and in tubes from 46,000 tons to 54,000 tons. It is pointed out, however, that the Polish industry is operating upon a restricted basis and that whilst five or six years ago the Krolewska-Laura concern employed 8000 men in 1934 it employed only 3300. The total export of rolled steel goods amounted in 1934 to 184,000 tons, or 40,000 tons less than the previous year. The exports to Russia diminished by 135,000 tons, so there apparently has been a gain of 95,000 tons in other markets. Exports of coal and iron enter largely into compensation agreements. A Polish-German arrangement, for instance, provides for the exchange of German raw materials for Polish rolled products; one with Russia exchanges Polish foundry iron for iron ore; while an agreement with Brazil allows the import of coffee, rubber, &c., in compensation for exports of Polish rails and other steel products. The report is obtainable at H.M. Stationery Office, price 1s. 6d.

Copper and Tin.

Business in electrolytic copper has shown a marked improvement during the past ten days. The reduction of the American official domestic price from 9c. to 8c. stimulated heavy buying in that country, and this imparted a better tone to the European markets. The export price has fluctuated, but has shown a firmer tendency than for some weeks past. Next week a meeting of the copper producers is to take place in London, and it is anticipated that some arrangement will be reached to carry out the provisions of the international agreement relating to the curtailment of production. The sharp fall in prices which occurred when the market believed that the agreement would be abandoned is thought to have impressed the copper producers with the necessity for carrying out the restriction of output arrangement. Whether it will be possible for the Americans to enforce their side of the agreement not to ship copper to Europe in excess of a stipulated tonnage seems doubtful. It will depend upon their success in forming an association which will represent the whole trade, including the customs smelters. British consumers have bought with some freedom, and Continental consumers also have shown considerable interest in the metal, although the difficulties of doing business in the export markets are still acute. Lately there has been a noticeable expansion in the demand for manufactured copper products, and this, of course, must be reflected in an improved demand for raw copper. On the London standard market slightly easier conditions developed early this week, but, on the whole, this market has absorbed some heavy selling better than might have been expected. At times there has been a tendency to cover in some of the sales rather quickly, and in spite of the slightly weaker tone of the market a more confident feeling prevails than for several weeks. . . . No change has taken place in the tin situation, and the market remains very much under control. American buying which developed on an active scale has not been maintained, but rather more business has been done lately with the Continent. The good impression made by the end of June statistics has done much to create a more cheerful tone in the market, but it has become obvious that the supplies in the immediate future will be on a more important scale, as sales in the Eastern markets have shown a marked expansion since the increased quota came into operation on July 1st. The backwardation, which fell below £5, has widened again, and the market does not seem to expect any relief from the scarcity of prompt metal.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
	(*D/d Teesside Area*)	
N.E. COAST—	£ s. d.	£ s. d.
Hematite Mixed Nos.	3 8 6	3 2 0
No. 1	3 9 0	3 3 6
Cleveland—	(*D/d Teesside Area*)	
No. 1	3 10 0	3 4 0
No. 3 G.M.B.	3 7 6	3 1 6
No. 4 Forge	3 6 6	3 0 6
Basic (*Less 5/– rebate*)	3 10 0	—
MIDLANDS—		
Staffs.—	(*Delivered to Black Country Station*)	
North Staffs. Foundry	3 11 0	—
„ „ Forge	3 6 6	—
Basic (*Less 5/– rebate*)	3 15 0	—
Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 11 0	—
No. 1 Foundry, ditto	3 12 6	—
No. 3 Foundry, ditto	3 10 0	—
Basic, d/d (*Less 5/– rebate*)	3 10 0	—
N.W. COAST—		
Hematite Mixed Nos.	3 12 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

MANUFACTURED IRON.

	Home.	Export.
LANCS.—	£ s. d.	£ s. d.
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. YORKS.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
MIDLANDS—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
No. 3 quality	7 10 0	—
No. 4 „	8 0 0	—
SCOTLAND—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. COAST—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

LONDON AND THE SOUTH—	Home. £ s. d.	Export. £ s. d.
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 6	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¼in. (basis)	9 0 0	7 15 0
„ ⅜in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅝in.	9 15 0	8 10 0
„ ¾in.	9 10 0	8 5 0
NORTH-EAST COAST—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Plates, ¼in.	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 5 0	8 5 0
MIDLANDS, AND LEEDS AND DISTRICT—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 7 6	7 15 0 to 8 5 0

STEEL (*continued*).

GLASGOW AND DISTRICT—	Home. £ s. d.	Export. £ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates	9 5 0	8 5 0
SOUTH WALES AREA—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 0
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 10 0	8 5 0

IRELAND—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¼in. (basis)	9 0 0	9 2 6
„ ⅜in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅝in.	9 15 0	9 17 6
„ ¾in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G. to 13-G., f.o.r.	9 0 0	8 15 0
14-G. to 20-G., d/d	10 5 0	9 0 0
21-G. to 24-G., d/d	10 10 0	9 5 0
25-G. to 27-G., d/d	11 2 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	13 0 0
2-ton to 4-ton lots	13 7 6
Under 2 tons	15 0 0

Export: £12 15s. 0d., c.i.f. India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel Ports, 18/2.
Tin-plate Bars, d/d South Wales Works, £5 5s. 0d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 to 250 tons	5 17 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£21 10 0	7/–
„ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 0 0	11/–
„ „ „ 1 p.c. carbon	£36 5 0	11/–
„ „ „ 0·70 p.c. carbon	£37 5 0	12/–
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 17 6 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/– to 5/6 per lb.	

NON-FERROUS METALS.

Official Prices, July 10th.

COPPER—	
Cash	£30 6 3 to £30 8 9
Three months	£30 13 9 to £30 16 3
Electrolytic	£33 10 0 to £34 10 0
Best Selected Ingots, d/d Birmingham	£33 10 0
Sheets, Hot Rolled	£62 0 0
	Home. Export.
Tubes, Solid Drawn (basis)	9½d. 9½d.
„ Brazed (basis)	9½d. 9½d.
BRASS—	
Ingots, 70/30, d/d Birmingham	£29 0 0 to £31 0 0
	Home. Export.
Tubes, Solid Drawn, 2/1 Alloy	9d. 9d.
„ Brazed	11d. 11d.
TIN—	
Cash	£231 0 0 to £231 5 0
Three months	£224 0 0 to £224 10 0
LEAD	£13 18 9 to £14 0 0
SPELTER	£13 13 9 to £13 17 6
Aluminium Ingots (British)	£100

FUELS.

SCOTLAND.

LANARKSHIRE—	Export.
(f.o.b. Grangemouth)—Navigation Unscreened	13/– to 13/6
„ Glasgow—Ell	14/6 to 15/6
„ „ Splint	17/–
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/– to 13/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	13/6 to 14/–
Unscreened Navigation	13/– to 13/6
LOTHIANS—	
(f.o.b. Leith)—Hartley Prime	12/6 to 13/–
Secondary Steam	11/9 to 12/3

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	18/6 to 21/6
Furnace Coke	15/– to 16/–
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	14/– to 14/6
„ Second	13/3 to 13/6
„ Best Small	10/6 to 11/–
Unscreened	12/6 to 13/6
DURHAM—	
Best Gas	14/8
Foundry Coke	19/– to 20/–

SHEFFIELD—	Inland.
Best Hand-picked Branch	23/– to 25/– —
South Yorkshire Best	20/– to 22/– —
South Yorkshire Seconds	17/– to 18/6 —
Rough Slacks	8/– to 9/– —
Nutty Slacks	7/– to 8/6 —

SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Bunker Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 26/–
Foundry Coke	24/– to 37/6
Furnace Coke	19/– to 21/6
Patent Fuel	21/–
SWANSEA—	
Anthracite Coals:	
Best Large	36/– to 40/–
Machine-made Cobbles	41/– to 48/6
Nuts	40/– to 48/6
Beans	25/– to 30/–
Peas	19/– to 23/–
Rubbly Culm	11/6 to 12/–
Steam Coals:	
Large Ordinary	18/– to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

French Engineering Notes.

(From our own Correspondent in Paris.)

Suppression of Quotas.

THE task of balancing the Budget which the Government has undertaken, with full powers to do everything that may be necessary for that purpose by issuing decrees during the next three months, can only be accomplished by retrieving sources of national revenue that have been dwindling with the continued decline of foreign trade. Monsieur Laval has made it clear that the Budget cannot be permanently balanced unless home production regains a normal activity, and imports are encouraged in order to provide increased revenue to the State. The plan for substituting a higher scale of import duties for quotas in a manner that will not disorganise industry is now under consideration, and the National Economic Council has been asked to offer suggestions as to what had best be done. The matter is so urgent that a solution would, no doubt, be readily found with the aid of the National Economic Council if it were not for the attitude of powerful industrial groups which are opposed to any removal of quotas until they are assured of adequate protection by tariffs, and in the present state of things those groups do not believe that tariffs can be high enough to protect them from the dumping of goods with the aid of export bounties. Suggestions are made that trading facilities should be provided amongst countries enjoying approximately the same standard of living and carrying on business under normal conditions, and that most-favoured-nation treatment should not be extended to other countries that do not offer the same guarantee of fair competition. If anything is to be done at all, the Government will have to act on its own initiative, and it is probable that during the next two months a number of decrees will be issued suppressing quotas and replacing them with higher import duties, preliminary to a more general plan of foreign trade development.

The Late Monsieur Citroen.

Monsieur André Citroën, who died in Paris last week at the age of fifty-seven, was one of the outstanding industrial personalities of the post-war period. A Parisian by birth, he obtained his promotion at the Ecole Polytechnique in 1900, and after a year's military service he started the manufacture of helical gears in a small shop with a few workmen, which eventually developed into the important affair of Citroën Gears on the Quai de Javel, near where the great motor car factory was to be established. Early in the war Monsieur Citroën offered to lay down a works for the production of shells. This offer the Government accepted, and in two months he erected machine shops and was satisfactorily fulfilling the terms of his guarantee. At the same time, his organising ability was utilised by the Government in various ways, notably in doubling the production of munitions at the Bourges Arsenal. After the Armistice Monsieur Citroën equipped his munition factory on the Quai de Javel for the manufacture of motor cars on a plan which was destined to change the outlook for the French automobile industry. He introduced mass production and borrowed from the United States ideas of labour-saving methods that enabled him to widen the market for cheaper cars. He built two factories outside Paris, and then reconstructed the Quai de Javel works and planned for a continually increasing production. He installed works in England, Germany, and other countries, and spent money lavishly on palatial showrooms at home and abroad, as well as upon ingenious publicity methods, such as illuminations in Paris and the use of the Eiffel Tower for luminous advertisements. His caravans across North Africa and through Asia had a geographical interest that associated the name of Citroën with scientific advancement. All this enterprise involved charges on the company that could only be justified by a continuous increase in the sale of cars the world over. When the slump came Monsieur Citroën would not admit that there could be a limit to the sale of cars. A withdrawal of credit brought disaster on the company, and pending its reconstruction the works were temporarily closed. Monsieur Citroën pursued aims beyond the limits of commercial prudence, and if he gave world-wide publicity to the French automobile industry, his failure has had a salutary effect in suppressing the competitive production of new models of cars.

Rolling Stock.

In its annual report the Chambre Syndicale des Constructeurs de Matérial Roulant severely criticises the Government policy in restricting purchases of rolling stock and of the railway companies building locomotives and wagons under conditions alleged to be far less satisfactory than those of private builders. All orders passed by the Superior Railway Council have to be approved by the Government, which, for financial reasons, has reduced them to an extent that seriously endangers the situation of builders. Between 1929 and 1934 the value of orders fell from 1150 million francs to 102 millions, the number of locomotives declining from 281 to 14 and of wagons from 17,145 to 380. The railway companies, it is affirmed, cannot build locomotives and wagons so cheaply as private firms when wages in the railway shops are fixed on a much higher scale under the "statute" imposed by the State on the companies for regulating the conditions of working. Wages and salaries on the railways represent more than 63 per cent. of the receipts, whereas before the war the percentage was 36. Again, objection is taken to the maintenance and repair of rolling stock by the railway companies at a cost which, it is stated, exceeds the cost of purchasing new material. The working of these shops contributes to the railway deficit, and economies can only be effected by competition with private builders. In the same way there would be an economy in scrapping old locomotives. Of the 19,600 locomotives owned by the companies and the State, only 12 per cent. are said to be less than ten years old, and it is alleged that more than a quarter of them exceeds thirty years. Last year the total number of coaches and wagons was 602,833, compared with 602,210 in 1926, and orders given out in the meantime showed that there were only 10 per cent. renewals. Private builders therefore insist that it is in the interest of the State and the railway companies to renew old rolling stock and to invite tenders for orders on the open market.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

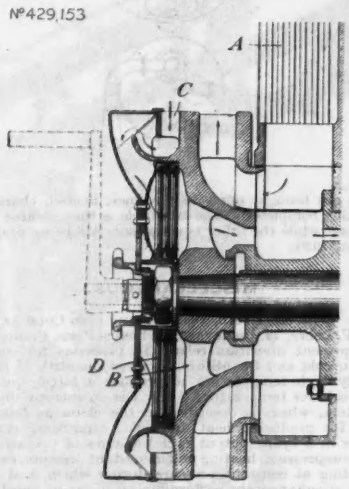
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

429,153. October 10th, 1934.—AIR INLET FILTERS, "Fusion-Moteurs," Boulevard Galliéni Rueil-Malmaison (Seine et Oise), France.

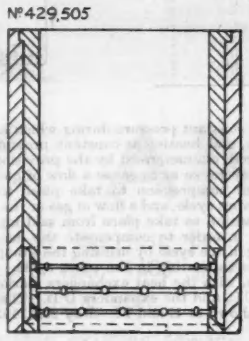
The fly-wheel of this engine appears to perform the dual functions of sucking air through the cooling radiator A and



cleaning the air going to the carburetter by a centrifugal action at C combined with a filtering through the plates D. This air is urged forward by the fan-like arms B of the fly-wheel. The cover of the whole assembly is readily removable for cleaning.—*May 24th*, 1935.

429,505. December 2nd, 1933.—CYLINDER LINERS, A. W. Roebuck Elmstead, Linney-road, Bramhall, Cheshire.

The lower part of the liner is grooved, as shown, and holes are drilled from these grooves into a passageway between the liner and the cylinder wall. One or more ports are made at the bottom to allow oil collecting in the passageway to fall into the crank case. The arrangement, according to the inventor, furnishes a simple system for reducing the hydraulic pressure

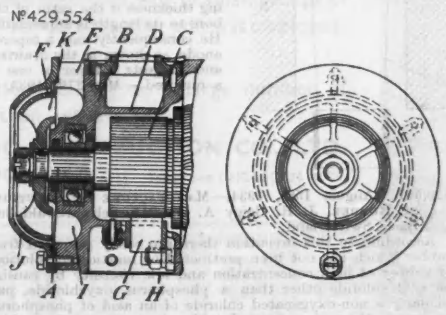


of oil set up by the rapidly descending piston, which is considerable about the lower part of the piston. When the lower part of the piston reaches the holes or slots, the hydraulic pressure is relieved because the oil is forced into the cavity surrounding the liner, from whence it is forced out and falls into the sump. As a consequence, less oil finds its way past the piston into the combustion space, and a saving in oil results, and a better lubricating effect is obtained.—*May 31st*, 1935.

DYNAMOS AND MOTORS.

429,554. July 30th, 1934.—COOLING OF COMMUTATORS OF DYNAMO-ELECTRIC MACHINES, G. Steiner, 6, Schaererstrasse, Solothurn, Switzerland.

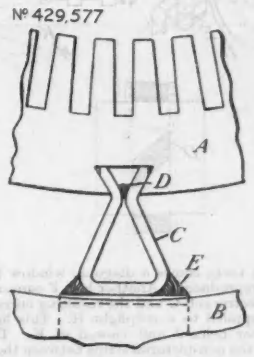
This invention relates to cooling devices for commutators



of dynamo-electric machines in which the commutators are totally enclosed. In the drawings A is the armature shaft with the commutator C. B is the commutator bearing cover, the extended part D of which is disposed with a small amount of clearance around the commutator. The carbon brushes G are shut off to the outside by a metal sheet H. With such an arrangement it is possible totally to enclose the commutator parts at which sparking occurs, so that all danger of fire is eliminated. The heat developed at the commutator is easily transmitted through the part D of the commutator bearing to the bearing body proper, and thence by way of the ribs E on the outer end surface of the bearing under the action of the fan F to the surroundings. The fan vane F has radially extending ribs K and is shut off from the outside by the cover J fixed to the bearing cover.—*May 31st*, 1935.

429,577. February 19th, 1935.—MANUFACTURE OF DYNAMO-ELECTRIC MACHINES, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

In the construction of dynamo-electric machines with built-up frames the inventors connect the laminations A with the frame

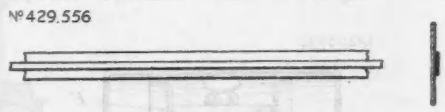


B by means of folded strips C. A few laminations are slipped on to the strips, the dovetail edges are then wedged apart and welded at D. More laminations are slipped on and the process repeated. The strips are welded to the frame at E.—*May 31st*, 1935.

ELECTRICAL APPLIANCES.

429,556. August 9th, 1934.—FUSABLE ELECTRICAL CONDUCTORS, J. Meech, 95, Mayo-road, Sydenham, London, S.E.26.

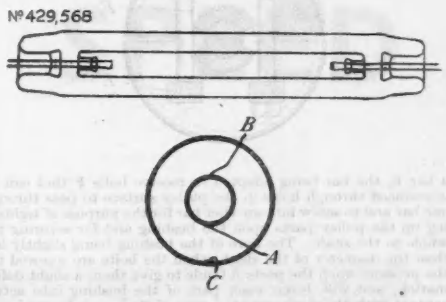
For the purposes of fire warning, the inventor proposes to use a thin strip of fusable alloy as an electric conductor. This



strip being of low mechanical strength is stuck on to a strip of paper. The paper is wider than the metal strip and the adhesive extending across its width serves also to fix it to the walls of the room to be protected. If the alloy is melted an alarm is sounded.—*May 31st*, 1935.

429,568. November 5th, 1934.—METAL VAPOUR DISCHARGE TUBES, N. V. Philips' Gloeilampenfabrieken, Emmasingel, Eindhoven, Province of North Brabant, Kingdom of the Netherlands.

Electric lamps of the sodium vapour type suffer from the disadvantage that some of the vapour may be condensed on the glass tube and reduce illumination. And the position of the deposit may be erratic on account of external cooling influences. Even a vacuum jacket does not entirely cure the

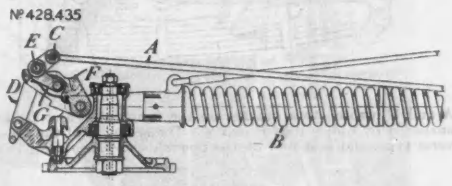


trouble. The inventors consequently apply a narrow strip of silvering A to the outside of the tube. This mirror, which is about 2 mm. wide for a tube 24 mm. in diameter, maintains the heat of that part of the tube and produces a correspondingly lower temperature on the opposite side at B. The surplus metal will be deposited there. As an alternative the mirror may be placed on the inside of the jacket at C.—*May 31st*, 1935.

TRAMWAYS AND RAILWAYS.

428,435. January 28th, 1935.—CURRENT COLLECTORS FOR ELECTRIC VEHICLES, C. L. Delachaux, 119, Avenue Louis Roche, Gennivilliers (Seine), France.

This device is intended to prevent the trolley pole from flying up in the air in the event of its slipping off the overhead wire. The pole is held up in the working position by the tension



in the rod A, which is produced by the spring B. The rod is anchored at C to a bell crank D, pivoted at E, which pivot is held in position on a cam plate F by the catch G. The action of the gear, which is fully described in the specification, is such that if the pole rises to an angle of about 45 deg. the catch G releases the pivot E, which slides back along the cam plate and reduces the tension produced by the spring.—*May 13th*, 1935.

TELEGRAPHS AND TELEPHONES.

429,570. November 30th, 1934.—TELEVISION SYSTEMS, Electrical Research Products Inc., 195, Broadway, New York, U.S.A.

In this apparatus light from a source A passes through a collimating lens B and through a scanning disc C. This disc is pierced with a spiral row of holes, each of which is fitted with

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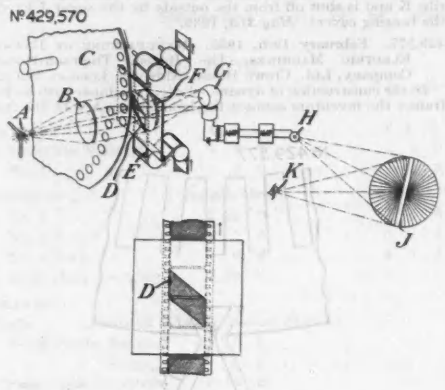

a lens. Next there comes a diagonal window D and then the film E to be reproduced. Another lens F concentrates the light on a photo-electric cell G and the resulting current, after amplification, is supplied to a striplight H. This light is projected on to a mirror helix J and viewed at K. The specification explains how the non-pictorial strips between the pictures on the film are eliminated.—*May 31st*, 1935.

TRANSMISSION OF POWER.

429,224. May 22nd, 1934.—BELT PULLEYS, F. S. Ward, 120, Princes-highway, Dandenong, Victoria, Australia.

This invention relates to the construction of belt pulleys of the split or divided type that are made in two parts and placed upon and secured to a shaft by bolting the two parts together. Referring to the drawings, the bushing A is made in two parts, each of which is appreciably less than a semi-circle, and the bushing is provided exteriorly with circumferential grooves B. The pulley C is in two parts, and on each part are cheeks D that are formed integral with the pulley or are attached thereto to extend inwardly from the belt-gripping surface thereof and to seat in the grooves B. Between the cheeks D on each part is

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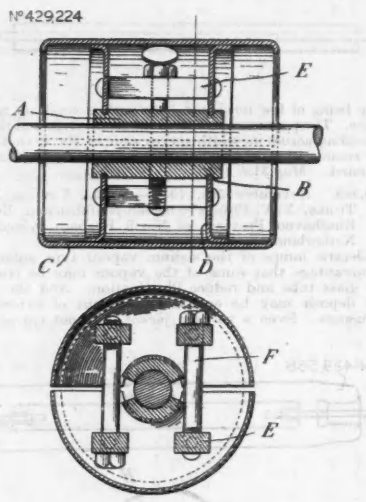

a bar E, the bar being adapted to receive bolts F that can be introduced through holes in the pulley surface to pass through one bar and to screw into another bar for the purpose of tightening up the pulley parts upon the bushing and for securing the whole to the shaft. The bore of the bushing being slightly less than the diameter of the shaft, when the bolts are screwed up, the pressure upon the parts A tends to give them a slight deformation, and will bring each part of the bushing into actual contact with the shaft over the area of its bore. By replacing the bushing for another having the same grooves, but a different bore, the same pulley parts can be employed upon a shaft of another diameter.—*May 27th*, 1935.

MOTOR CARS AND ROAD TRAFFIC.

429,169. December 15th, 1933.—WHEEL SUSPENSION SYSTEMS, L. M. Ballamy, 63, Old Town, Clapham, London, S.W.4.

This invention is concerned with the front wheels of motor cars. The front axle is divided into two pieces

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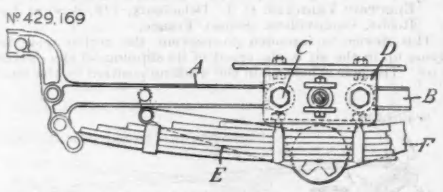

A and B pivoted to a bracket on the frame at C and D, and anchored by radius rods E and F. The spring is of the transverse type, and is shared by the two wheels.—*May 24th*, 1935.

FURNACES.

429,562. September 27th, 1934.—METALLURGICAL FURNACES, Karl Schmidt Gesellschaft mit Beschränkter Haftung, 10, Fabrikstrasse, Neckarsulm, Württemberg, Germany.

This furnace arrangement seems to be specially adapted to the melting and refining of copper. Four furnaces A are mounted on a turntable B. These furnaces are of the rotary ellipsoid type, and are heated by the return flame from a burner C. The waste gases go away by the flue D. The weight of the furnace is carried by rollers E, which are mounted on jacks F, so that the inclination can be adjusted. In working two of the

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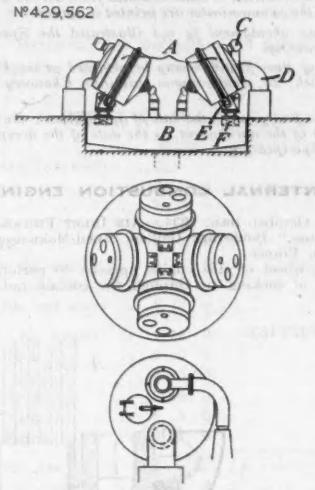


furnaces are brought opposite the flues, heated, charged, and the refining completed. The turntable is then rotated and the charge cast while the other two furnaces are being prepared.—*May 31st*, 1935.

MISCELLANEOUS.

429,172. September 18th, 1933.—PRODUCING COLD AND HEAT, A. F. Lebre, 74, Boulevard Exelmans, Paris, France.

This present invention relates to processes for converting heat into cold and for utilising a given quantity of heat at a relatively high temperature to produce a larger quantity of heat at a lower temperature. Fig. 1 is an entropy diagram of the system, which is described in the claim as follows:—A process for producing heat and cold, comprising performing on a gas in a cycle (output cycle) a series of operations comprising compression, heating under constant pressure, expansion, and cooling at constant pressure during which heat is given off, and simultaneously performing on a gas in another cycle (input cycle) a series of operations comprising compression,

Nº429,172

Fig.1

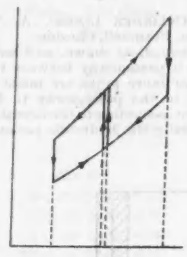
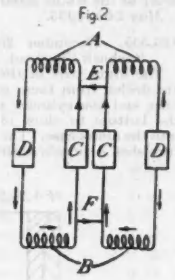
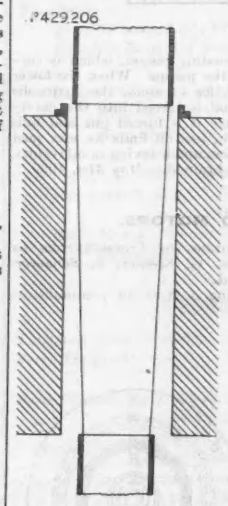


Fig.2



cooling under constant pressure during which heat is also given off, expansion, and heating at constant pressure during which cold is produced, characterised by the provision of connections between said cycles so as to cause a flow of gas at the pressure obtaining after compression to take place from said output cycle to said input cycle, and a flow of gas at the pressure obtaining after expansion to take place from said input cycle to said output cycle, in order to compensate the decrease in volume due to cooling in one cycle by utilising the simultaneous increase in volume due to heating in the other cycle. Fig. 2 indicates the apparatus, with the heat exchangers marked A and B, the compressors C C, and the expanders D D. The interconnecting passages are shown at E and F.—*May 20th*, 1935.

Nº429,206



429,206. February 1st, 1934.—DEPOSITING CHROMIUM ON CYLINDER BORES, H. van der Horst, 22, Alexanderlaan, Hilversum, Holland.

The inventor advocates the lining of the bore of internal combustion cylinders with chromium on account of its resistance to corrosion, but explains that if the usual arrangement of cylindrical anode is used there is a liability for the deposit to be of tapering thickness if the ratio of the bore to its length is appreciable. He consequently uses a tapered anode, as shown in the drawing, and suggests a taper of one in a hundred.—*May 27th*, 1935.

429,557. August 15th, 1934.—MANUFACTURE OF SOLUTIONS OF RUBBER, J. R. Geigy A. G., 215, Schwarzwaldallee, Basle, Switzerland.

According to this invention there are easily prepared from rubber which has not been pretreated or masticated solutions of rubber of high concentration and low viscosity by causing an acid chloride other than a phosphorus oxychloride, particularly a non-oxygenated chloride of an acid of phosphorus, to act on the non-pretreated rubber in presence of a rubber solvent, the quantity of acid chloride ranging from about 5 to 10 per cent. of the weight of the rubber. A particularly favourable action is shown by phosphorus trichloride, which permits the production of solutions of 15 per cent. strength and more within a few hours. Phosphorus pentachloride and other acid chlorides, such as chloracetyl chloride, para-toluene sulphochloride, cymene sulphochloride, or compounds having the character of acid chlorides, such as antimony trichloride, are less active than phosphorus trichloride, but nevertheless permit the production of solutions of 6–7 per cent. strength in a few hours. The rubber solutions obtainable in accordance with the invention find application in the production of conversion products of rubber. The following example illustrates the invention, the parts being by weight:—Eleven parts of first heves latex crepe are introduced into a mixture of 89 parts of chlorobenzene and 0·6 part of phosphorus trichloride having a temperature of 65 deg. Cent., and the whole is stirred at 70–75 deg. Cent. until it has become a thin liquid. At a temperature of 70–75 deg. Cent. this requires about 10–12 hours, but by increasing the temperature to 90–95 deg. Cent. the duration of the treatment may be shortened to 3–5 hours.—*May 31st*, 1935.

429,576. February 5th, 1935.—THE MANUFACTURE OF ENGINE CRANK SHAFTS, The Ford Motor Company, Ltd., 88, Regent-street, London, W.1.

This is a process for casting petrol engine crank shafts. The mould is made of a pile of plates of baked core sand and provides

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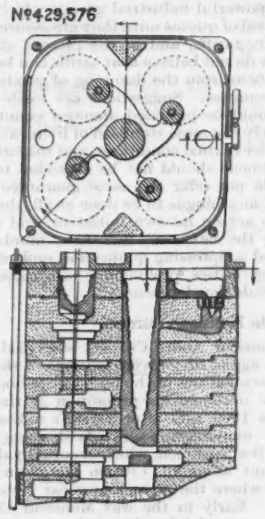

for the simultaneous casting of four shafts from one central runner. It is stated that the feeders must enter the moulds slightly below the middle of the length of the shaft, otherwise a porous casting will be produced. The mould is so shaped that the shaft as cast is slightly bowed, but comes straight when it cools down.—*May 31st*, 1935.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Queen's Hotel, Keighley. Annual general meeting. 8 p.m.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

STOTHERT AND PITT, Ltd., of Bath, have recently obtained several important orders for multi-bucket excavators for brick-works and sand and gravel pits. Included in the machines now under construction are one to operate in depth on a face of 60ft., one to operate in height on a face of 50ft., and another mounted on caterpillars and fitted with screening equipment

DAVEY, PAXMAN AND CO. (Colchester), Ltd., have recently received, among others, the following orders for their marine oil engines:—Two twin-screw installations, one consisting of two 30 h.p. Paxman-Ricardo engines fitted with reverse gears, installed in a recently launched 45ft. cruiser, and an identical twin set with 4/1 reduction gears for installation in a motor yacht now building at Yarmouth; a twin set consisting of six-cylinder Paxman-Richardo engines developing 225 h.p. each, with reducing gears for a twin-screw vessel for British Guiana, to the order of the Crown Agents; two sets each of 68 h.p. Paxman-Ricardo engines, fitted with reverse and reduction gears for installation in fishing boats which are to be laid down by Mr. Walter Reekie, of St. Monance; and also a number of engines for auxiliary duty.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE ROTARY AIR COMPRESSOR COMPANY, Ltd., has changed its address to 119, Victoria-street, London, S.W.1.

MR. SIDNEY A. AMOS, M.Eng., who has been practising as a consulting Diesel engineer, has now joined the staff of Germ Lubricants, Ltd., London, E.C.2.

MR. J. A. HOLLINGS, for many years general manager and director of Geo. H. Hughes, Ltd., St. Stephen's Wheel Works, Birmingham, has been appointed joint managing director.

MR. S. MCEWEN has joined the board of directors of Mitchell Engineering, Ltd. (founded as Mitchell Conveyor and Transporter Company, Ltd.), of No. 1, Bedford-square, W.C.1. This addition to the board is in consequence of the increase in the company's activities following the acquisition of the rights for Loeffler high-pressure boilers and of facilities for the manufacture and supply of water-tube boilers.